NOV 29 1937

# SCIENCE EDUCATION

THE SCIENCE MAGAZINE FOR ALL SCIENCE TEACHERS
FORMERLY GENERAL SCIENCE QUARTERLY

PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

Methods of Using Science in Health Education and Health Approach to Science

Cooperative Science Testing Results in Philadelphia High Schools

A Biology Radio Broadcast Program

Student Laboratory versus Teacher Demonstration as a Means of Developing in Students the Ability of Laboratory Resourcefulness

Radio Fade-Outs and Solar Eruptions

Classroom Notes

Comrades in Research—an Editorial

What Shall Be the Place of Science in Education—an Editorial

VOLUME 21
NUMBER 4
NOVEMBER 1937

UPERIOR QUALITY • DEPEN-
LE SERVICE • FAIR PRICE
• SUPERIOR QUALITY • FAIR PRICE • DEPENDABLE SERVICE • SUPERIOR QU

# SKELETONS ☆ MODELS ☆ TYPE SPECIMENS

BECAUSE the basic principle in science is to see and interpret, the modern laboratory must provide an abundance of objective material designed to initiate as well as verify concepts. The Chicago Apparatus Company anticipates this need and offers reliable biological laboratory equipment and supplies embodying the very latest improvements and finest quality. Marine and Inland Plants and Animals are prepared in specimen jars to afford full vision . . . Skeletons are expertly prepared in our own laboratory in any standard mounting desired for individual requirements . . . Zoological and Plant models are American made and constantly on supply . . . Patten Chick Embryo Models, designed by an American authority for American institutions, are available in a series of seven critical stages in chick embryology: 18-hour (the primitive streak) to the 96-hour stage.

These are just a few of the thousands of items listed in the latest catalog—No. 47. Write for yours today.

**Illustrated. Left:** Patten Chick Embryo Model—44-hour stage.

**Right:** Gila Monster (Heloderma Suspectum)

**Chicago Apparatus Company**

*Science Laboratory Equipment*

1735 NORTH ASHLAND AVENUE • CHICAGO U. S. A.

# Science Education

*Formerly* GENERAL SCIENCE QUARTERLY

**Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions**

**Volume 21** **NOVEMBER, 1937** **Number 4**

# Contents

(The Contents of SCIENCE EDUCATION are indexed in the Educational Index)

How Science Teaching May Reinforce Health Education ..... *Ruth Strang* 173

The Cooperative Science Tests in Philadelphia Public High Schools. Results and Interpretations ..... *Edw. E. Wildman* 178

Biology on the Air ..... *W. E. Bruner and Students* 181

Student Laboratory Work Versus Teacher Demonstration as a Means of Developing Laboratory Resourcefulness ..... *Philip Goldstein* 185

Radio Fade-Outs and Solar Eruptions ..... *R. S. Richardson* 193

Classroom Notes ..... 199

Editorial and Educational News ..... 201

Abstracts ..... 206

New Publications ..... 210

PUBLISHED BY

SCIENCE EDUCATION, INCORPORATED

Communications regarding manuscripts should be sent to the Editor, Science Education, 32 Washington Place, New York City. Major articles should be no longer than 3,000 words; classroom notes should be limited to 500 words. "Suggestions to Authors" will be sent upon request.

Correspondence regarding advertising, subscriptions and business matters should be addressed to the Business Manager, Science Education, Evansville College, Evansville, Indiana. The subscription price is $2.50 a year; $3.50 in Canada and other foreign countries. Single copies are 50 cents; 65 cents in foreign countries. Prices on back numbers will be sent on request. Prices on reprints of articles are available to authors.

FALL 1937 PUBLICATIONS

**Gruenberg-Unzicker**

## SCIENCE IN OUR LIVES

A general course for the ninth year which leads the student to think of science as a way of solving many kinds of problems.

**Glenn-Welton**

## CHEMISTRY ACHIEVEMENT TESTS

Tests for first and second semester of the high school chemistry course.

## World Book Company

**Yonkers-on-Hudson, N. Y. - - 2126 Prairie Ave., Chicago**

## THE TEACHING BIOLOGIST

**(A Publication for Biologists who Teach)**

*Biology Teachers* are enthusiastic about our journal. Many of them have written in to tell us how useful it is in their work. You, too, will find its contents pedagogically, professionally and scientifically useful. Send for a sample copy.

Please send me a sample copy of The Teaching Biologist as well as further particulars about it.

Name .....

Address .....

City and State .....

THE TEACHING BIOLOGIST

published by

The New York Association of Biology Teachers

Barnet S. Minters, Business Manager

5420 90th Street, Elmhurst, L. I., N. Y.

# Science Education

## HOW SCIENCE TEACHING MAY REINFORCE HEALTH EDUCATION*

RUTH STRANG

*Associate Professor of Education, Teachers College, Columbia University*

### THE NATURE OF HEALTH EDUCATION

Health Education is first of all intent on healthful living. Its central concern is that children acquire the culture and mores pertaining to personal and community health. Knowledge and attitudes are important in so far as they make clear what action is to be taken or motivate action that is already recognized as healthful.

Scientific knowledge, from the standpoint of health education thus defined, is a means to an end, not an end in itself, while health knowledge is that area of scientific thought which more or less directly functions in healthful living. There are many odd and interesting facts in the world, but these do not constitute health subject-matter. Health facts should be functional. A good question to apply to the content of any book purporting to teach health is: "Would these paragraphs or illustrations help a person in any way to live more healthfully?" Teachers are guided by the carefully built text in choosing among the multitudes of facts that might be taught the ones that are most closely associated with healthful living. Without that guidance teachers untrained in health education are likely to lapse into irrelevancies and to lose their way in a maze of trivialities.

Attitudes enter into healthful behavior to an important degree, sometimes overriding scientific knowledge. A class of seventh grade boys who knew very well that insanitary drinking cups are means of transmitting communicable diseases and who had investigated the insanitary method which a certain pushcart man used in washing his drinking glasses, nevertheless continued to drink his so-called lemonade because, they said, "He bought an ad for our school paper, and we can't let him down." The attitude of loyalty in this case was more potent than scientific reasons.

Since healthful living, obviously, is not confined to any one period of the school day, health education permeates the entire school program. In that respect it resembles character education. It is an intrinsic part of all school activities.

### OVERLAPPING CONTENT IN HEALTH EDUCATION AND SCIENCE EDUCATION

Science education, too, has many ramifications with other subjects, but it is not so pervasive as health education. In view of the essential nature of health education and the wide applications of science to modern life, one would expect considerable overlapping between these two fields.

If health education and science education were each represented by a circle, there would be a sector common to both. How large it would be has not been precisely determined. It is the purpose of this article to make a preliminary exploration of the common ground in these two fields.

### HEALTH CONTENT IN ELEMENTARY SCIENCE

There is some evidence that science content plays an increasingly large part in health education from the first grade through high school. From birth children should be engaged in the establishment of

*Presented at the meeting of the National Council on Elementary Science on February 20, 1937, in New Orleans, Louisiana.

good health habits. This process of habit formation is vigorously continued during the elementary grades, and may be reinforced by scientific knowledge. In the first six grades the overlap in topics between a health series and a science series, both recently published and both based on extensive curriculum research, is surprisingly small.*

The two series selected for study were the Macmillan *Health and Growth Series*[1] and the Ginn *Pathways in Science Series*[2] for grades one to six. The health series was based on extensive curriculum research consisting ot an analysis of the best existing courses of study and texts; mortality, morbidity and accident statistics for adults and for children of different ages; expert opinion as to important health knowledge; popular health sources of information in magazine and newspaper; health problems observed by teachers in different grades; children's expressed interest in and knowledge of health subject matter; and their comprehension of the vocabulary used in the texts. The science series was based on somewhat similar curriculum research. Accordingly, these two series should represent the most approved content for health and science respectively.

A marked lack of duplication was evident. In the first-grade science book there was no content that could be strictly classified as health subject matter. The health series presented the topics of diet and food, exercise and posture, cleanliness, good mental habits, safety and first aid, sanitation, sleep and clothing in connection with everyday situations. The science series was concerned with a fascinating presentation of the elementary scientific aspects of the world about us.

In the second grade, there were forty-three pages that might be classified as health education material. These forty-three pages were divided among four topics: clothing, diet and food, air and breathing, and sanitation. In the third-grade science book, which was devoted chiefly to the story of the sky and the evolution of plant and animal life on the earth, there were included only fourteen pages that might be classified as functional health information. In the fourth-grade science book which dealt with the social, chemical and physical aspects of the earth and living things, nine pages at the most were directly focused on health behavior. The fifth-grade science text included an interesting discussion of the migration of birds and animals, hibernation, protective coloring, weather conditions, magnetism and electricity, the sky and other subjects of science, but only eleven pages on the everyday health problems of children. The proportion of health content in the sixth-grade science book was similar except for a greater emphasis on sanitation.

Apparently these two series, the Science Series and the Health Series, supplement each other almost perfectly. This is desirable. Each accomplishes thereby its own task. The science series gives a background of appreciation of the world and life in it, while the health series focuses attention on children's everyday experiences of healthful living. In the first six grades of elementary school, if we can judge by this analysis of two carefully constructed series, there is very little overlap in the content of health texts and science texts.

Although in the elementary school it does not seem wise to attempt to teach health through science, or science through health, there are, however, many opportunities for health education in the teaching of science units. The children should then, as at other times during the school day, choose chairs and tables the right height for them; sit with the light falling on their work, not in their eyes; hold their books up instead of laying them flat on the table; take responsibility for maintaining an optimum room temperature, and establish other similar good health habits. During the study of

* The author is indebted to Miss Laurena Lord for making the analysis of the two series.

[1] W. W. Charters, Dean F. Smiley, Ruth Strang. *Health and Growth Series*, Grades one to eight. New York: The Macmillan Company, 1934–1935.

[2] Gerald S. Craig *et al.* *Pathways in Science Series.* Boston: Ginn and Company.

science there are likewise many opportunities for the teacher to promote good habits of mental health. A little first-grade girl began to cry because she had lost her book. The teacher suggested a better way of meeting that situation by saying, "Why don't you look in such and such places for your book?" Accordingly, the little girl trotted off to look for her book, thus substituting an active response to difficulty for an ineffectual method of response. Perhaps most important of all is the whole-hearted interest the science teachers may elicit from their classes. According to Burnham, such undivided absorption in the present is both an indication and a means of promoting mental health. If these and similar experiences in healthful living are emphasized in the lower elementary grades, the re-inforcement of health habits by science education may well be delayed until junior high school years.

### HEALTH CONTENT IN HIGH-SCHOOL SCIENCE

Analyses of the health content of secondary school science textbooks, on the other hand, show a large percentage of health material in general science and biology textbooks. Meier[3] analyzed the health content of four textbooks used in junior and senior high schools in each of four subjects. The percentages of health material, generously estimated as such, were as follows:

50 per cent of the biology books
32 " " " " general science books
11 " " " " chemistry books
2 " " " " physics books

In addition to a similar analysis of science textbooks, Chappelear[4] analyzed forty courses of study in the same sciences, college entrance examination questions and New York State Regents' examination for biology, chemistry and physics for the years 1916 to 1926, and a check list of 276 health statements on which 200 teachers of science indicated the topics which they taught. The percentages of health subject matter in a given field was fairly uniform. In the three sources the percentages of pages of health subject matter were as follows:

| | | | *Examinations* | |
|---|---|---|---|---|
| | *Texts* | *Courses of Study* | *College Board* | *Regents* |
| General Science ... | 31 | 35 | | |
| Biology ..... | 37 | 39 | 33 | 32 |
| Chemistry ..... | 9 | 15 | 6 | 8 |
| Physics ..... | 3 | 5 | 3 | 1 |

The health topics most fully treated in science textbooks are foods and disease. More specifically, Chappelear found the following phases of health education emphasized in each of the following divisions of science:

| *General Science* | *Biology* |
|---|---|
| Foods (nutrition and digestion) | Foods |
| Disease | Disease |
| Air | Heart and circulatory system |
| Eyes | Mental hygiene |
| | Posture and exercise |

| *Chemistry* | *Physics* |
|---|---|
| Foods | Air |
| Cleanliness | Eyes |
| Safety | Foods |
| Clothing | |
| Disease | |

There is a tendency for general science and biology to include a wide range of health content as compared with the restricted range found in chemistry and physics textbooks and courses of study. Sleep, rest and fatigue, and the elimination of body wastes receive only slight treatment in general science. The courses of study follow the same general pattern of health content as the textbooks with a somewhat greater proportion of emphasis on cleanliness, posture, alcohol, tobacco and drugs.

[3] Lois Meier. *Health Materials in Science Textbooks.* New York: Bureau of Publications, Teachers College, Columbia University, 1927. 104 p.

[4] Claude S. Chappelear. *Health Subject Matter in Natural Science.* New York: Bureau of Publications, Teachers College, Columbia University, 1929. 108 p.

A number of important health topics are omitted entirely from the College Entrance Board and the New York State Regents Examinations.

### DISADVANTAGES OF LEAVING HEALTH EDUCATION TO SEPARATE SCIENCE COURSES

There is considerable overlapping of the health content of biology with that of general science. If the health content in the two subjects is presented with different and new emphases, it will reinforce convictions concerning health practices. If, on the other hand, the overlapping is a mere repetition of previously covered content, it will be distasteful and tiresome to the students. Numerous examples of the latter type of overlapping were found particularly in respect to foods and diseases in biology and general science books. Since general science is taken by a much larger percentage of students than are the other more specialized sciences, it should be considered basic and the health subject matter in the other subjects adjusted to prevent deadening and unnecessary overlapping.

These analyses of science material show clearly a large amount of health content in general science and biology textbooks and courses of study and considerable health knowledge of an important nature in all four science subjects. But whether the scientific facts having implications for people's health function in the daily lives of children is another question. Although certain educational philosophers have declared that concomitant learning is more usable and lasting than direct learning, psychological experiments indicate the opposite. Psychologists have repeatedly demonstrated that a person acquires the habits and knowledge to which his attention is specifically directed. For example, lists of words studied with one purpose in mind are not learned in other relationships.

There is the possible danger of loss to both health and science in incidental teaching of health in science classes. From the standpoint of health, the incidental application of scientific facts to healthful living is likely to be too weak and lacking in focus to move to action. From the standpoint of science, some of the elation that pupils may experience when they first come in contact with some fundamental natural law, will be dissipated if their attention is diverted at that point to everyday health applications.

### ADVANTAGES OF AN INTEGRATED CURRICULUM FEATURING HEALTH PROBLEMS

In a truly integrated curriculum in the high school, the danger both of wasteful or tiresome overlapping and of a too tangential approach may be avoided. In such a set-up, it is possible to begin with real health problems in the lives of the students and their community and to bring to bear on the solution of these problems relevant facts from every available scientific source. This form of organization is better than the incidental correlation of health with other subjects for two main reasons: first, it focuses an impressive array of facts in support of a given health procedure, and second, it insures all students contact with essential health subject matter. One of the weaknesses of the correlation method is that all pupils do not take all the subjects which together would give a well-rounded basis of health information. This criticism of the attempt to teach healthful living through the subjects of the high school does not deny the desirability of making "every part of the school curriculum that is intrinsically related to health education contributory to the acquisition of ideals and the formation of habits affecting the pupils' health and the health of others."[5]

### THE SCIENTIFIC APPROACH TO HEALTH PROBLEMS

The health education value of a given science lesson depends upon how it is taught. It will have the maximum health value if the attention is focused on the health values in the careful way described

[5] Thomas D. Wood, Chairman. *Health Education.* Report of the Joint Committee on Health Problems in Education of the National Education Association and the American Medical Association, 1924. 76 p.

by Laton[6] in a biology unit on communicable diseases. First, a choice of diseases for study was made on the basis of: (1) diseases causing death, especially those which are important factors in the mortality of children of school age; (2) diseases causing illness, especially those which occur among children of school age; (3) diseases against which a constant campaign must be waged in order to prevent epidemics; (4) diseases of local importance.

Second, a choice of significant material concerning these diseases was made. The material taught was that which students would be called on to use. It was taught in relation to the situations in which they will need to use it. What was taught was determined by the use that the learner would be called on to make of the knowledge. The layman for whom secondary education is primarily planned needs a knowledge of the means of prevention, skills in the application of such knowledge and attitudes motivating the functioning of the knowledge and skills. Knowledge of symptoms and treatment, on the other hand, are in the province of the physician who specializes in communicable diseases. For the layman, knowledge of the ways in which he may protect himself and others from disease constitutes the core of health education so far as the communicable diseases are concerned.

Third, specific objectives in terms of activities, knowledge and attitudes were prepared which would distinguish a person who had studied diphtheria from one who had not. The following are examples of these objectives: "Be Schick tested if that seems advisable." "Older people are generally immune." "The Schick Test is harmless and picks out the non-immune." "The attitude of cooperation in all well-founded attempts to lessen diphtheria morbidity and mortality."

Fourth, as many specific experiences as possible which underlie the scientific concepts were used in building up the necessary abstract ideas. Many concrete experiences and generalizations which the pupils had already acquired were used to build up more definite and accurate thought patterns. This approach to the study of biology in the high school through real health problems is not only an effective method of health education; it is likewise a good way to teach biology. One of the main reasons why so large an amount of the science taught in high school does not function later in the lives of the pupils is that "there was insufficient relation between the subject matter presented and the various activities of their daily lives."[7]

Moreover, the health problem approach in high school contributes to fundamental generalizations in science such as those relating to the composition of matter, the causation of disease, the interrelationships of living things, and the scientific method of settling issues on the basis of ascertainable facts. Generalizations derived from material so rich in human interest as personal and community health problems are very likely to be clearly understood and extensively used. The health content already incorporated in science textbooks and courses of study can be increased in value by the best psychological methods of teaching with a gain to science as well as to health. Science through health is as plausible as health through science.

In 1879, Kingsley wrote: "I am going to throw myself into this movement. I am tired of most things in the world; of sanitary reform I shall never grow tired. No one can accuse a man of being sentimental over it, or of doing too much of it. There can be no mistake about the saving of lives, and the training up of a healthy generation." There is the same challenge today to "train up a healthy generation." One way of doing this is to reinforce health education by the application of scientific content to real health problems.

[6] Anita Laton. *The Psychology of Learning Applied to Health Education through Biology.* New York: Bureau of Publications, Teachers College, Columbia University, 1929. p. 19–32.

[7] Margery Stewart Gillson. *Developing a High School Chemistry Course Adapted to the Differentiated Needs of Boys and Girls.* New York: Bureau of Publications, Teachers College, 1937.

# THE COOPERATIVE SCIENCE TESTS IN PHILADELPHIA PUBLIC HIGH SCHOOLS. RESULTS AND INTERPRETATIONS*

EDW. E. WILDMAN

*Director of Science Education, Philadelphia, Pa.*

During the past school years, covering June, 1934, and June, 1936, more than 10,000 cooperative tests were administered by our Division of Educational Research in fifteen subjects in our Philadelphia high schools.

These tests were used primarily in supplementing the achievement records of pupils. But in addition to this important function, they give us a measure of the achievement of our pupils compared with that of those in other sections of the country.

*Test norms.* The authors' norms for these tests were established upon the work of pupils in public high schools characterized mainly as suburban schools specializing in college preparation.

*Numbers tested.* The number of pupils tested here varied from 10 to 100 per cent of the enrolment in the special subjects. Accordingly, the groups varied in selection, and we cannot tell the effect of this variation.

*Results in all subjects.* Of the total of all tests given, the city mean is 3.1, or slightly more than the author's norm of 3.

*Results in science.* More tests were used in science than in any other subject. Yet the city mean in this subject stands at 3.4. The city mean in English alone equals that in science, but only about half as many pupils took the English tests, and they were pupils of more than average ability. For the most part, they had completed successfully seven terms of high school English. The relatively high city score in science therefore would seem to be significant. Let us see if we can find a significant explanation for it.

In analyzing our problem, a number of factors will cancel out at once. For example, much as I should like to think that our science teachers are superior to all of their colleagues, prudence keeps me from boasting by reminding me that all of our teachers must be college graduates, that all are appointed only from the top of eligible lists, and that it is probably just about as difficult to put oneself at the top of any other list as it is to get to the top of the science lists.

As to equipment needed for work, and the time allotment on the school roster, we get our share, but no more. So far as curriculums are concerned, we are about as well off as the rest, but no better, because our tentative outlines of courses, like those in all the other subjects, were built up almost entirely by committees of teachers, with principals and supervisors acting merely as advisers. Finally, as for teaching techniques employed, it is safe to say that our science teachers are as faulty, or as adroit, in their pedagogy as are their colleagues.

Therefore, after cancelling out all of these common factors that might be thought of as entering into the solution of our problem, it would seem that the significant factor in bringing about the better performance of our science pupils in this series of tests, which were wholly impartially prepared, administered and marked, must lie much deeper than in any of these more or less mechanical factors of instruction.

As teachers of science, we all readily admit that our subject is the most interesting,

* Presented at the New Orleans meeting of N. A. R. S. T., February 23, 1937.

and we all know that interest is the mainspring of effort. We also know that effort is still the only guarantee of success. Now there are certain factors in the cultural history of Philadelphia which have set a strong current of interest among its youth toward the sciences. Since its founding, the city has been a leader in the two great fields of applied science, namely, industry and medicine. This fact has been both the cause and the result of interest in the study of science.

The Quaker founders were dissenters from the Established Church in England, and so were barred from Cambridge and Oxford. William Penn himself was expelled from Oxford because he refused to conform to its rules of religious observances, as a result of his conviction of the truth of the message of a Quaker minister whom he heard while a student there. Being thus barred from the great English universities, the young men of the Society of Friends turned to Edinburgh and other non-conformist universities for their education. In these schools they found great emphasis placed upon the study of mathematics and science, because these fields presented less play for controversy than many others. Having completed their training, these early Quakers made important contributions to the cultural life of Britain. Dr. John Fothergill, and Dr. John Lettson and the London cloth merchant and botanist, Peter Collinson, were a few of the Quaker Fellows of the Royal Society who were well known in England during the middle eighteenth century. On this side, James Logan, the cultured Irish secretary of William Penn, John Bartram and his son William, and David Rittenhouse, among others, set a high standard of interest in science during those early decades of the city's life. It was this atmosphere that Franklin found when he came to the city from Boston, and his genius flourished in it, and indeed, did much to strengthen it.

There can be no doubt that this local interest in science has far-reaching effects politically also, for Franklin founded the American Philosophical Society in 1727, and invited as members the leading men in all the colonies. Through its meetings and work his acquaintance with these men and with scientists in England grew for decades. As a result, Franklin had contacts of the greatest value when the colonies needed a representative in Europe. It was by no accident that the conventions leading to the framing of the Declaration of Independence and to the adoption of our Constitution after the War here held in Philadelphia.

Tomorrow we are to hear a discussion on the subject, "The Use of Background in the Interpretations of Educational Issues." I would make a plea for the recognition of the value of a knowledge of the cultural background of your own community, wherever it may be, especially as to its present or traditional interest in science and its applications. Such parental and adult interest unconsciously gives our pupils an interest in science which is of great value to us as teachers.

Many of you work in schools in cities of the South. Perhaps you have seen the recently published study of Professor Johnson,[1] of the University of Virginia. In this book you will find, thoroughly proved, the thesis of the author that we are in error when we think that the culture of the old South was centered in the study and enjoyment of the classics. With ample documentation, Professor Johnson and his co-workers have shown that in every important southern center, before 1860, science played a large part in the curriculum of every college and state university, and even in the numerous academies, both for young men and young women. Scientific societies also flourished in every city. Perhaps the most dramatic story in the book is the account of the intense interest in science shown at Transylvania University, Lexington, Kentucky, and the zeal shown in collecting ap-

[1] Johnson, Thomas C. *Scientific Interests of the Old South.* New York: D. Appleton-Century, 1936. 217 p.

paratus and books for use there, in the early days of the nineteenth century, when long and difficult journeys were made to Philadelphia to purchase these, and later to London and Paris. The work of scientists in Charleston and in New Orleans, to mention only two other centers, was well known in the American Philosophical Society at Philadelphia, the Smithsonian Institution at Washington, and the Royal Society in London. Invention, industry, and medicine in the South quite naturally benefited as the result of this interest.

Let us therefore, as science teachers, wherever our work may be, use this part of our cultural heritage, first to enlist through it the interest of the adults of our community; and through them the increased interest of our students. My birthplace was many hundreds of miles from Philadelphia, but my years of work in her schools have led me to realize that her teachers of science have an asset in her cultural and economic history which is of very real value to them in their work.

Franklin's Philosophical Society still continues its work; John Bartram's house which he built with his own hands in 1731 still stands in the midst of his garden; the Library Company of Philadelphia, founded by Franklin and his friends that same year, is still in the service of the community. (These men, you recall, sent their money to Peter Collinson in London to buy books for them at the beginning, and it was he who sent Franklin the "electrical machine" in 1746 which, Franklin later said, started him on his study of electricity.) The Franklin Institute, founded in 1824 in his honor, is housed today in a magnificent building on the Parkway, and its memorial museum is filled with a thousand exhibits illustrating as many phases and uses of the forces of nature about us; the Academy of Natural Sciences, next door on the Parkway, founded in 1812, is still serving the community as a center for the study of the natural sciences, and now increasing rapidly its facilities for popular museum instruction; the Pennsylvania Horticultural Society, founded in 1828, is still actively stimulating interest in plant culture; and Franklin's Charity School, founded in 1740, and Medical School, founded in 1768, now the University of Pennsylvania, is one of the leading medical and scientific centers of the world.

In some way, every one of our science teachers has come in vital touch with one or more of these inspiring centers of culture. Inevitably, this inspiration gets passed on in the classroom, and to a less or greater extent is contagious there.

Under these circumstances, science teaching never can be confined to the limits of a textbook, nor couched within the phraseology that happens to be current at the moment in professional colleges for teachers. Under these circumstances, ideally, science teaching must be living, growing, dynamic and even adventurous. Indeed it is only upon such teaching of science that our progress in industry and medicine can look with hope for the future, so far as producers are concerned, and for the vast majority of our pupils who will, perforce, be the consumers of the products of industry and medicine, this kind of instruction will go far to help them to weigh the evidence, to discriminate between fact and pseudo-fact, and to seek truth at its source.

Let us then seek out the cultural, scientific mores of our several communities and make use of their inspirational values with our pupils. You recall President Conklin's luncheon message at our session last December, summed up in his final thought. ". . . Information, illumination, inspiration—these three; but the greatest of these is inspiration."

Considering all of these things, then, it is not surprising that our pupils did well in the cooperative tests. Indeed, if they had not, we Philadelphia teachers would be doubly to blame.

# BIOLOGY ON THE AIR

W. E. Bruner and students
*Nebraska State Teachers College, Kearney, Nebraska*

*Introduction of sponsor.* Thank you, Mr. Roth, for this opportunity to greet the friends of K. S. T. C. Old friends, call on us in the Biology Department when you're in Kearney. You may feel pretty sure that Miss Ludden will call you by name. If you are not acquainted start by visiting our museum room. Even though it is largely a teaching museum, you'll find it interesting. If you stay long enough, you may see the clams curiously walking on their stomach in search of food. Also of interest are the white rats, rabbits, and a fine collection of birds, some of which are quite rare.

For those interested there is a teaching collection of about 2500 mounted plants. Merrill Hendricks, one of our seniors, has been putting these specimens in first-class order. Many people seldom see a skeleton except in the wreckage of the Christmas goose. See the skeletons of animals and birds all assembled in working order.

Speaking of skeletons, one day I was enthusiastically lecturing to my class on the wonders of nature when—imagine the sensation—I looked to my right and there was Napoleon staring at me with his mouth wide open. Napoleon is the student name for the human skeleton and someone had unhooked his jaws.

And now you will listen to the random conversation of some biology students. The first voice will be that of Merrill Hendrickson (M), the second that of Addah Jane Ludden (A), and a little later you will hear Duncan Wagner (D).

*M* Boy, oh boy, isn't this some weather? I certainly wish it would warm up.

*A* I guess the weather has been freakish everywhere. Did you hear what happened when it snowed in Tucson, Arizona?

*M* No, what?

*A* The University students got into such a snow-ball battle that the cops were called to stop the fight. They were snow-balled off the campus and what's more, they refused to come back.

*D* I thought we were going to talk about biology this evening.

*A* I suppose you think the weather has nothing to do with biology.

*D* Oh, I suppose it has some effect but not this time of the year.

*M* Won't this cold weather kill a great many insects?

*D* I read the other day that, according to the state entomology department, this cold weather would have no effect on the grasshopper situation. Grasshoppers have so adapted themselves to cold winters that their eggs are not destroyed by cold.

*A* Yes, the eggs, very true, but guess what. The biology class found grasshopper eggs hatching before the cold weather started. They will be killed. Of course we don't know how many have hatched.

*M* After all, the critical time is the hatch-

Editor's Note:

*This program, sponsored by the Biology Department, was successfully presented by three biology students. Its success was attributed by the sponsor to the following facts: (1) It included items of local and seasonal interest; (2) The parts were adapted to the speakers' personality and habits of speech; and (3) It was spontaneous because it was written by the cast which produced it and it contained items in which all were interested.*

*The author states it is not presumed that this program can be used without considerable modification but it is hoped that other teachers and pupils may find it useful in preparing similar entertainment and instruction.*

ing period in the spring. If it's cold and damp they will become diseased and die in large numbers. Spring weather will determine if we are to have another grasshopper plague.

*A* Well, insects are important enough to think about.

*D* Yes, there are many scientists who seriously question whether insects or man will be the last to survive.

*A* If the insects destroy our food supplies and the white ants wreck our buildings and the fly and mosquito carry disease. . . .

*M* But we must remember that we have intelligence while insects have only instincts.

*D* Only instincts, did you say? Do you realize how wonderful instincts are?

*A* Yes. Merrill, can you, with your intelligence, take a needle and stick it into a caterpillar's brain every shot?

*M* No, and nobody else could.

*A* But a wasp can. That is instinct, not intelligence.

*D* What do you mean, stick a needle into its brain?

*A* Well, you see the wasp is confronted with the problem of maintaining a fresh food supply for its young. So it stings the caterpillar in its nerve centers and paralyzes it. The wasp then carries it home and the little wasps, when they are hatched, are assured of fresh food, even though the parent wasp has long forgotten them.

*M* Another good example of instinct is the case of Pronuba moth, which pollinates the soapweed. This little insect visits the flower, first gathering a ball of pollen with her mouthparts, lays an egg in the seed pod and then pollinates the flower to insure seed development. The grubs then have the developing seeds to feed on. However, they never eat them all. Some are always left to mature.

*A* But wouldn't the seeds develop anyway?

*M* Soapweed plants have been observed for twenty years where the Pronuba moth was not present. During all this time no seeds were produced.

*D* That is not only an example of instinct but also an example of interdependence of living things.

*M* Yes, devices to accomplish pollination have some very intricate adjustments. Darwin said, "The coordination between a flower and the particular insect which pollinates it may be as delicate as that between a clock and its key." For example, a Madagascar orchid with its long, slender nectaries requires the services of a moth with a beak or probascis nearly twelve inches in length to cross-pollinate the flowers.

*D* Do human beings have instincts as wonderful as insects have?

*A* I think human beings are prompted to many of their actions by instinct but it is guided or modified by intelligence.

*M* I have often wondered if our fear of snakes is instinctive.

*D* Some authorities believe it is, but Dr. Ditmars, curator of reptiles at New York Zoological Park, says that we learn to fear snakes. We either have unpleasant experiences with them early in life or we are taught to fear them by hearing of the experiences of others.

*A* Do you think that parents and teachers should teach children to fear snakes?

*M* All should learn how useful snakes are and know them well enough that it will not break up a picnic or produce hysteria if one makes an appearance.

*D* There aren't many kinds of poisonous snakes in the United States, are there?

*A* There are only four kinds. The rattlesnake, moccasin, copperhead, and coral snake are the only poisonous kinds and the coral is found only in the extreme south.

*M* Is there any general way to tell a poisonous snake from a non-poisonous one?

*A* The rattlesnake, moccasin, and copperhead all belong to the pit-viper group. They have a characteristic pit between

the eye and the nostril on each side of their head.

*M* I don't intend to get close enough to see that.

*A* Well, they also have a triangular head and elliptical eyes. None of these snakes are very common in this part of the country.

*D* I am glad of that but how about black widow spiders? They have become so common I should like to know more about them.

*M* Ask Addah Jane. She has a good line on spiders.

*D* How can you tell a black widow if you see one?

*A* Black widows can be recognized by the hour-glass shaped spot on the underside of the abdomen.

*D* Are they common in this section of the country?

*A* Generally black widows are not common in this section, but in the southern part of the United States. However, during the drought many moved north and are now rather common here.

*D* Are they really poisonous?

*A* They are really poisonous. They possess poison glands, which inject poison into the victim.

*D* Is their bite fatal?

*A* Their bite is not always fatal, although authorities disagree.

*D* Where is one most likely to find them?

*A* Black widows live in dark places, for example, in garages or basements.

*D* How can one get rid of them?

*A* They can be destroyed by fumigating with carbon bisulphide.

*D* Suppose one bites you. Is there anything to do besides grin and bear it?

*A* Surely! Even our local drug stores keep a fresh supply of serum for counteracting the poison.

*D* Well, that answers almost everything, except—why is she called a black widow?

*A* Because she is a widow! She is a cannibal—she always eats her husband and thinks nothing of eating some of her own children.

*M* Well, I'd say you know your insects.

*D* I say you don't know them. A spider isn't an insect.

*M* It looks like a bug to me. Why isn't it?

*D* One easy way to tell that a spider isn't an insect is because it has eight legs while an insect has only six.

*A* Oh, this is altogether too serious for me. Rest your brains and tell me this. Do you wear ear muffs?

*D* Yes, everybody does this year.

*A* Well, I heard a new one today—you wear ear muffs but do you know what an ear *wig* is?

*D* An ear *wig?*

*A* Give up?

*D* I don't think there is such a thing.

*A* Oh yes, there is. An ear wig is a small insect so named because it is supposed to crawl into the human ear. Yet it is perfectly harmless.

*D* Well, now if you are so clever, explain this. If you pick a guinea pig up by its tail its eyes will drop out.

*A* No animal would be like that.

*D* I'll bet you a candy bar.

*A* If you pick it up by its tail its eyes will fall out.

*D* No, you have to do it.

*M* Be careful how much you bet, Addah Jane. A guinea pig has no tail.

*D* That may be biology but it's not getting us any place. You know, I've been thinking about the flood situation in the East. Won't the balance of nature be very much upset in the flood area? What do you think?

*A* Well, all of the native animals will probably be drowned over many hundreds of square miles.

*M* Perhaps some of the trees and other plants which are submerged for several days will be drowned, too.

*A* Who ever heard of plants drowning, grass for instance?

*M* Didn't you learn once that all living protoplasm requires food and oxygen?

*A* Well, yes, but then plants don't need oxygen in winter.

*M* Why not? Are they dead?

*A* No, we say they are dormant.

*M* Then, if they are still living, they require some oxygen—only a little, however, so perhaps the flood may not seriously damage vegetation.

*D* Speaking of floods—today's paper says that eight out of every ten of the refugees have the influenza.

*M* With a million refugees that would mean 800,000 people with the influenza.

*A* Aren't they vaccinating them?

*M* Probably not for the influenza.

*A* Why don't they?

*M* For one reason the cause isn't definitely established.

*A* Do you mean the doctors don't know what causes influenza?

*D* About forty years ago Pfeiffer found that influenza patients had a germ which seemed to be causing the trouble and that this germ gave guinea pigs the influenza, so after much experimentation he named it the influenza bacillus.

*A* So that is what causes influenza?

*M* No, his results have not been confirmed. Others believe that it is caused by an invisible germ called a filtrable virus.

*A* Well, then is it caused by a filtrable virus?

*M* Unfortunately experts can not agree so the best we can do is say that the cause is not definitely known. It is just one of the many things which scientists still have to discover.

*A* We've been studying fungi. Some one tell me the difference between a mushroom and a toadstool.

*D* Botanically speaking, there is no difference. Both belong to the same order. Popular opinion places all poisonous species under the head "toadstool" and all edible species under the name "mushroom."

*M* Then, if there is no definite difference, how can one of the poisonous varieties be told from the non-poisonous?

*D* Most botanists agree that the only way to tell the two apart is to eat them. If you are ill, or die, the species is poisonous. If not, it will be safe to eat them again, if you get the same thing. The danger is not so great, however, for if once you become familiar with the characteristics of a species, it is not difficult to recognize it again.

*A* I have always considered it wonderful that mushrooms should grow to full size overnight. They must be about the fastest growing things on earth.

*D* The idea is almost entirely erroneous. First, the mushroom grows vegetatively for a long period of time under ground. Secondly—a mushroom bud or button appears and slowly fills out. The third thing which happens is that the mushroom comes up and expands. This is much like the behavior of a flower bud. Both develop slowly for weeks or months before they are completely formed. The mushroom is the fruiting structure of the fungus.

*A* Well, that is a new one to me. But you mentioned the fruiting structure, which reminds me of another question which I have wished to ask. What is the difference between a fruit and a vegetable, and why is a tomato called a fruit?

*M* The term vegetable is a common name and is not scientifically defined while the term fruit is botanically defined as that portion of a plant which contains seeds. So you see why a tomato is called a fruit.

*A* Listen to this. I found it in an old paper—It's a ditty about a field trip.

And we gather as we travel,
Bits of moss and dirty gravel,
And we chip off little specimens of stone;
And we carry home as prizes
Little bugs of handy sizes,
Just to give the day a scientific tone.

*M* People surely have queer ideas about biology.

*D* Yes, to most people it means only cutting up ugly, foul smelly creatures to find out how they work.

*M* One has to study all kinds of animals in order to appreciate any of them. It makes you appreciate much more what a human being is. My idea of life and living things is certainly changing.

*D* Well, it all depends on who's talking. In genetics we learned that a person is just what the genes which he inherits make him.

*A* Oh, I don't believe that. I think environment is just as important—even more so. What people have to eat, especially in childhood. . . .

*M* Yes, and what kind of homes they have and their education is more important.

*A* Why, I've seen some of the most ill-clad, most backward children become entirely changed in a couple of years when their father got a good job. How do genes explain that? It looks like environment to me.

*D* That's just where you are wrong? The genes which you inherit determine your natural ability. Environment may decide how well that ability is developed.

*A* I still don't see.

*D* Well, suppose you go out to Reservoir Hill with your camera and take a picture of it. When you have it developed what do you expect to see?

*A* A picture of the hill, of course.

*M* I tried developing my own picture once and you should have seen what I got.

*D* Well, you didn't give the exposed film the right environment to bring out what was in it.

*M* What are you talking about?

*D* I can make the whole problem of inheritance and heredity much clearer by the following comparison. Let us compare the impression on the exposed film to the individual bearing the impression of the inherited genes. The developing solution is the environment for the film. Now if you use the right developing solution you could develop the impression of Reservoir Hill into a picture of Pikes Peak, couldn't you?

*A* Why, certainly not.

*D* Well, neither can you take a child who has inherited genes from inferior, diseased, criminally-inclined and feeble-minded parentage and by suitable environment hope to produce a grand intelligent personality.

*A* I think I begin to see what you mean. Environment can bring out and develop only the abilities which are transmitted by the impression of the inherited genes.

*M* It was just that sort of thing that Alexis Carrel was talking about in his book *Man, The Unknown* when he said that we can improve the race by developing the strong, not by fostering the weak.

# STUDENT LABORATORY WORK VERSUS TEACHER DEMONSTRATION AS A MEANS OF DEVELOPING LABORATORY RESOURCEFULNESS*

PHILIP GOLDSTEIN

*Seward Park High School, New York City*

## THE PROBLEM

This study attempted to find out whether allowing students to do laboratory work is a better way for them to develop laboratory resourcefulness than is teacher demonstration of the same material. In this connection, resourcefulness is defined as the ability to form a plan of action, when faced by a problem in the laboratory, and to carry it to a successful conclusion with the materials at hand.

The question of resourcefulness in the laboratory has not been studied to any great extent. A review of the literature revealed only two studies[1,2] that deal directly with

* A digest of a thesis submitted for the degree of Master of Science in Education at the College of the City of New York, February, 1937.

[1] Webb, H. A. *School Science and Mathematics* 22: 259–267; 1922.

[2] Beauchamp, R. O., and Webb, H. A. *School Science and Mathematics* 27: 457–465; 1927.

this trait. Yet it is an important trait, and merits more attention. The difficulty involved in measuring resourcefulness is one factor which retards further study.

A consideration of resourcefulness fits in with other educational problems of the moment. For a long time there has been discussion of the place of individual laboratory work in the teaching of science. This discussion has not yet yielded conclusions satisfactory to all. It has been demonstrated that achievement on written tests is just as good whether the individual laboratory method or teacher demonstration is used in teaching the material.[3, 4, 5] The latter method, however, is more economical of time and money.[6] Hence it has been argued that individual laboratory work be abandoned in favor of the demonstration method in the teaching of science.

However, in a survey of the field made in 1925, Riedel[7] showed that most of the earlier studies dealing with the question of laboratory and demonstration teaching, had many serious faults. In his analysis he showed that many of the conclusions formed as a result of these studies were based on meager experimental data, covering few cases, in poorly controlled experiments. Furthermore, he found that, *"No research known to the writer has made an adequate measurement of other than the merely informational aspect of teaching."*[8] Elsewhere Riedel states, "There are probably other abilities not measured by these tests or by any tests yet constructed, . . ."[9]

Obviously, results on rewritten tests which measure only knowledge of facts should not be the sole measures of success considered when one method is to be dropped in favor of another. Perhaps certain useful traits developed by the individual laboratory method are unique to that method of instruction. Perhaps written tests do not measure these traits at all. This is suggested by Riedel's survey and in studies by Carpenter[10] and Horton.[11] The idea is aptly summarized in the Thirty-first Yearbook which states, "Each method offers training in certain knowledges, skills, and habits not offered by the other."[12]

Resourcefulness seems to be one such trait, and since it is an important factor in life, the school should attempt to develop it in the student. The question then arises, as to which method is better for developing resourcefulness. If it is shown that watching demonstrations is not as effective a means of developing resourcefulness as handling the apparatus is, certainly the individual laboratory method should be favored even though it costs more in time and money.

As early as 1922, Webb concluded that the lack of laboratory resourcefulness was due to unfamiliarity with laboratory materials. Again, in 1927, Beachamp and Webb concluded that experience was the major causative factor of resourcefulness. If these conclusions are to be accepted as correct, then individual laboratory work must be given as the only means of developing resourcefulness, for during a demonstration it is the teacher (and not the pupil) who is developing resourcefulness by gaining familiarity with materials and by gaining experience in solving problems.

[3] Johnson, P. O. *Journal of Educational Research* 18: 103–111; 1928.

[4] Kiebler, E. W., and Woody, C. *Journal of Educational Research* 7: 50–58; 1923.

[5] Carpenter, W. W. *Certain Phases of the Adminstration of High School Chemistry.* Contributions to Education, No. 191. New York: Teachers College, Columbia University, 1925.

[6] Downing, E. R. *School Review* 32: 688–697; 1925.

[7] Riedel, F. A. *School Science and Mathematics* 27: 512–519, 620–631; 1927.

[8] *Ibid.*, page 517.

[9] *Ibid.*, page 630.

[10] Carpenter, W. W. *Certain Phases of the Administration of High School Chemistry.* Contributions to Education, No. 191. New York: Teachers College, Columbia University, 1925.

[11] Horton, R. E. *Measurable Outcomes of Individual Laboratory Work in High School Chemistry.* Contributions to Education, No. 303. New York: Teachers College, Columbia University, 1928.

[12] National Society for the Study of Education. *Thirty-first Yearbook,* Part I. Bloomington, Ill.: Public School Publishing Co., 1932, page 106.

This present study therefore attempts to measure experimentally the actual effect on resourcefulness of learning by the two methods involved in the foregoing discussion.

## THE METHOD

The obvious method of attacking this problem is to equate two classes in the same grade of science, teach one by the laboratory method and the other by the demonstration method, test both groups for resourcefulness, and compare the results. Unfortunately, the school at which this experiment was carried out is unequipped with laboratory accommodations for class use. There is one demonstration table, with apparatus enough for demonstration only. Hence it was decided to attempt the solution of the problem with small groups after school.

The actual performance of the experiment may be broken up into four phases, namely—

A. The Preliminary Work.
B. Forming the Experimental Groups.
C. The Practice Period.
D. Testing Resourcefulness.

*A. The Preliminary Work.* During the term of September, 1935, volunteers were called for in the science classes at this school* to participate in an experiment. Those who volunteered were subjected to a series of "tests of resourcefulness." The purpose of the preliminary work was to determine whether the instructions were clear and understandable, to determine the amount of time that should be allowed for the completion of a test, and to discover a uniform method of administering the tests during the subsequent experiment.

In all, thirty-one students were regular enough in attendance to make a complete set of results available. It was realized that some means of tying up this after-school activity with the regular class work was necessary, to make students take the work more seriously, and be more regular in their attendance.

*B. Forming the Experimental Groups.* At the beginning of the following term, volunteers were again called for in the science classes.** This time the pupils were told that only a limited number could be used, and that those who were ultimately chosen could earn extra credit toward their class marks in science by serving conscientiously. About eighty pupils volunteered in all. They were subjected to a battery of tests, and their records were studied for the purpose of equation. Two groups of twenty each were finally selected, equated as closely as possible for the factors indicated below:

1. Sex (all the subjects were girls).
2. Term in high school.
3. Age.
4. Class in science.
5. Otis I.Q.
6. Average of prepared major in high school.
7. Score on Powers General Science Test.
8. Score on Initial Test (covering the subject matter studied in the practice part of the experiment).

A third equated group was formed by selecting twenty subjects from the preliminary experiments. This group was to serve as a control, or No Practice Group.

*C. The Practice Period.* Meanwhile, five experiments had been devised to serve as the material to be learned during the practice period. Each experiment was prepared by putting the necessary apparatus and materials into a box together with a typewritten sheet of instructions for the performance of the experiment. After all the preliminary testing had been completed and the experimental groups had been selected, each group performed all five experiments.

* The subjects were all drawn from the science classes of Annex 4 of Seward Park High School in New York City. All the students at this annex are girls.

** Fortunately, most of the pupils who had participated in the preliminary work had been transferred to another building. The few that remained, and volunteered again, were rejected.

The subjects of the Laboratory Group worked in pairs, five pairs coming every Tuesday and five pairs every Thursday. Each pair performed one experiment a week. The subjects of the Demonstration Group sat as a class, ten coming on Wednesdays, and ten on Fridays. The teacher demonstrated. To insure uniformity, the teacher followed the same instruction sheets as were used by the Laboratory Group.

At the completion of an experiment in either group, each student wrote it up individually. The written paper was handed to the teacher who checked it in the presence of the student, and retained it. When all the subjects had completed all five experiments, the completed set of written papers was returned to each student. The subjects were told that at their next meeting, there would be a test on the material covered by the experiments. During the following week, the final test (identical with the initial test), was administered.

The results showed that both groups did equally well in regard to learning the subject matter of the experiments, since there was no significant difference between the groups in regard to their improvement.*

The practice period of the experiment ended with the administration of the final test.

*D. Testing Resourcefulness.* After the completion of the practice period, the rest of the experiment consisted of administering the tests of resourcefulness to each student according to a uniform method which had been adopted. Two tests were set up each week, and the subjects were called in one at a time. As each finished, she was sent out of the building without returning to the room where the other subjects waited to be called.

The materials were arranged in a definite way on the laboratory table. When a subject entered the room, she was handed a library card on which was typed a list of the given materials, and the problem to be solved. The student immediately set to work, while the experimenter timed her with a stop-watch. If the student completed the problem successfully, the experimenter noted the success. If the subject worked for five minutes without successfully completing the solution, it was noted as a failure. The experimenter made no remarks or suggestions during the conduct of the test, except that when a subject presented an incorrect solution to a problem before the expiration of the time limit, she was told, "This is not correct. Try again."

A description of each test of resourcefulness used in this study, follows. Next to each test is indicated the number of successful solutions presented (of a maximum of sixty), and the rank in difficulty (1 is easiest). This description is not identical with the instruction card handed to the subjects taking the tests.

THE TESTS OF RESOURCEFULNESS

*Test 1* (Successful 55, Rank 1 easiest)

Given—1. Bunsen Burner
2. Rubber tubing
3. Matches
4. Test tube of water mounted on a ring stand

Instructions—Using only the materials given, boil the water in the test tube.

*Test 2* (Successful 3, Rank 10)

Given—1. Two bottles of unequal weight
2. Container of water
3. A one hundred gram weight
4. A platform balance

Instructions—Using only the materials given, weigh out exactly one hundred grams of water.

*Test 3* (Successful 27, Rank 6)

Given—1. Bottle
2. Pan
3. Glass plate
4. Source of water

Instructions—Fill the bottle full of water, and stand it upside down in the pan *without letting any air into the bottle.*

*Test 4* (Successful 47, Rank 3)

Given—1. Battery jar full of water
2. Small bottle
3. Long glass tube

* This is in agreement with other studies, which show that pupils studying science by either the laboratory or the demonstration method, do equally well on written tests covering subject matter.

Instructions—Fill the bottle full of water from from the battery jar *without moving either the bottle or the jar.*

*Test 5* (Successful 24, Rank 7)

Given—1. Two dry cells
2. A flashlight bulb which will not light on one dry cell, but will light on two dry cells connected in series.
3. Socket for the bulb
4. Several pieces of copper wire.

Instructions—Light the lamp.

*Test 6* (Successful 10, Rank 9)

Given—1. Bottle.
2. Sand.
3. Container of water.
4. A two ounce weight.

Instructions—Using only the materials given, weigh out exactly four ounces of sand.

*Test 7* (Successful 17, Rank 8)

Given—1. Battery jar full of water.
2. Bottle.
3. Rubber tube.

Instructions—Fill the bottle full of water from the jar, without moving either the bottle or the jar.

*Test 8* (Successful 49, Rank 2)

Given—1. A meter stick with hooks at 10 cm. intervals, which is suspended at its center from a stand.
2. A one hundred gram weight.
3. A two hundred gram weight.

Instructions—Balance the weights by hanging them on opposite ends of the stick.

*Test 9* (Successful 32, Rank 5)

Given—1. One dry cell.
2. An electric bell.
3. A single pole, single throw, knife switch.
4. Three pieces of copper wire.

Instructions—Connect up the bell so that it will ring only when the switch is thrown.

*Test 10* (Successful 43, Rank 4)

Given—1. A fifty gram weight.
2. A twenty gram weight.
3. A platform balance.
4. Sand.

Instructions—Weigh out exactly 30 grams of sand.

## THE RESULTS

Essentially, this experiment consisted of testing for resourcefulness, three equal groups that had received different types of practice with materials. In the text which follows, these groups will be referred to as Group I, II, and III, for the No Practice, Demonstration, and Laboratory Groups respectively. The results may best be summarized by a few tables chosen from those of the complete report.

TABLE I

RESULTS ON TESTS OF RESOURCEFULNESS BY GROUPS

| | *Group I* | *Group II* | *Group III* |
|---|---|---|---|
| Number of tests successfully completed .. | 85 | 104 | 118 |
| Rank in resourcefulness ..... | Less | Second | Most |

Table I shows the number of tests of resourcefulness successfully completed by each group as a whole out of a maximum of 200 tests. But of the 200 successes that any group might achieve, apparently 85 can be scored without previous practice (since that is the number scored by the No Practice Group. That leaves 115 as the maximum possible improvement due to practice. In that case, Group II improved $\frac{19}{115}$ or 16.6 per cent whereas Group III improved $\frac{33}{115}$ or 28.7 per cent over Group I.

It is evident that the greater improvement in resourcefulness is on the part of the Laboratory Group as a whole.

This method of attack, however, does not show whether the differences are real and significant. Another approach to the same question might be through a consideration of the resourcefulness of individuals in each group, instead of groups as a whole. The resourcefulness of a subject may be considered as varying directly as the number of tests of resourcefulness she is able to complete.

Table II compares the mean resourcefulness of the subjects of each group.

This table shows again that the advantage lies with the Laboratory Group, since the

TABLE II
THE AVERAGE RESOURCEFULNESS OF THE SUBJECTS OF EACH GROUP

| | *Group I* | *Group II* | *Group III* |
|---|---|---|---|
| Mean resourcefulness of group ..... | 4.75 | 5.70 | 6.40 |
| S. D. ..... | 1.55 | 1.57 | 1.58 |
| Standard Error of Mean ..... | .35 | .35 | .35 |

average resourcefulness of members of that group is higher than the average of the other two groups. Since the S.D. is approximately the same for all groups, it indicates that the variability of all the groups is about the same, and that consequently their distribution curves have the same spread. But the means are not the same. Hence the entire curve of resourcefulness of the Laboratory or Demonstration Group has shifted towards the upper end of the scale of resourcefulness.

Obviously, the greater shift is on the part of the Laboratory Group.

Table III compares the differences among the means of the three groups.

These figures show a true and statistically significant difference between the resourcefulness of the Laboratory Group and the No Practice Group, and a smaller difference between the Demonstration Group and the No Practice Group. It is evident again that the Laboratory Group developed a greater degree of resourcefulness than did the Demonstration Group.

It is of interest to study a bit further the distribution of each group. If all the sixty subjects are lumped together, and then the entire group is divided into quartiles, it becomes clearer that the Laboratory Group is the more resourceful. Table IV shows the distribution of Groups I, II, and III in the quartile division of the entire group.

TABLE IV
DISTRIBUTION OF THE SUBJECTS OF GROUPS I, II, AND III IN THE QUARTILE DIVISION OF THE ENTIRE GROUP

| *Quartile* | *The fifteen subjects in the quartile are distributed as follows* | | |
|---|---|---|---|
| | *Group I* | *Group II* | *Group III* |
| 1st (highest) ... | 3 | 5 | 7 |
| 2nd ..... | 2.5 | 5.5 | 7 |
| 3rd ..... | 5.5 | 5 | 4.5 |
| 4th (lowest) ... | 9 | 4.5 | 1.5 |
| Total .. | 20 | 20 | 20 |

Table IV reads: Of the sixty subjects tested for resourcefulness, the fifteen found to be most resourceful were distributed in the ratio of 7 from the Laboratory Group, to 5 from the Demonstration Group, to 3 from the No Practice Group. The rest of the table reads similarly.

The data of Table IV are shown graphically in Fig. 1.

TABLE III*
CHANCES THAT REAL DIFFERENCES EXIST AMONG THE MEANS OF RESOURCEFULNESS OF GROUPS I, II, AND III

| *Group* | *Mean* | $\varepsilon_M$ | *Difference between two means* | $\varepsilon_d$ | $\frac{d}{\varepsilon_d}$ | *Approximate chances that difference is real* |
|---|---|---|---|---|---|---|
| I .... | 4.75 | .35 | | | | |
| | | | .95 | .49 | 1.92 | 35 : 1 |
| II .... | 5.70 | .35 | | | | |
| | | | .70 | .49 | 1.43 | 12 : 1 |
| III .... | 6.40 | .35 | | | | |
| | | | 1.65 | .49 | 3.37 | 2,660 : 1 |
| I .... | 4.75 | .35 | | | | |

* Figures in the last column of this table taken from a table on page 137, Tiegs, E. W., and Crawford, C. C., *Statistics for Teachers.* Boston: Houghton Mifflin Co., 1930.

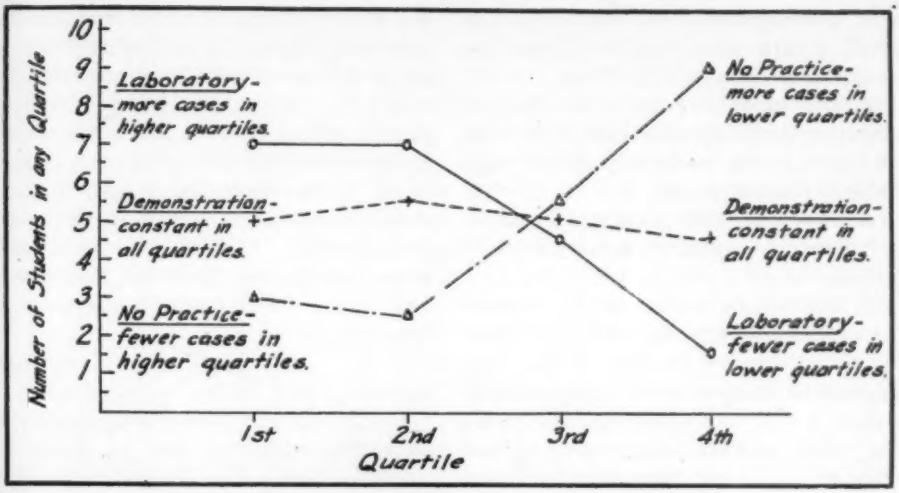


FIGURE 1.

Both Table IV and Fig. 1 show the same trend clearly. Most of the subjects of the Laboratory Group find places in the upper quartiles, and fewer in the lower quartiles. The No Practice Group shows just the opposite trend, namely, few cases in the upper quartiles and many cases in the lower quartiles. The Demonstration Group takes a place intermediate between the two, with about the same number of cases in each quartile.

Here again the laboratory method shows its superiority in developing resourcefulness, because that trait was developed to a higher degree, in a larger number of subjects by this method than by the demonstration method.

A number of correlations were worked out to show the relationship between degree of resourcefulness and various factors. These correlations were compared with correlations given by Beauchamp and Webb. Table V makes this comparison, but discussion is postponed to the section called "Conclusions."

## CONCLUSIONS

Certain limitations of this study must be kept in mind in considering the conclusions. Chief among them are:

TABLE V

CORRELATIONS OF THIS STUDY COMPARED WITH THOSE OF BEAUCHAMP AND WEBB

| *Resourcefulness correlated with* | *As measured by* | *Given by Beauchamp and Webb* | *Found in this experiment* |
|---|---|---|---|
| Intelligence | Otis I.Q. | .21 ± .09 | .37 ± .08 |
| | Tests in Phys. & Chem. | .19 ± .09 | ..... |
| Achievement | Average of H. S. major subjects | ..... | .24 ± .08 |
| | Average of Science Marks | ..... | .32 ± .08 |
| Maturity | Age | ..... | −.07 ± .09 |
| Experience | ? | .60 ± .06 | ..... |
| | Terms of Sci. | ..... | −.04 ± .09 |

1. The experiment was performed with small groups after school. Hence the results may not apply to classes.

2. The subjects were volunteers, and therefore the groups may have been select. In that case, the results may not be applicable to random groups.

3. Since only girls participated, the results may not be applicable to boys or mixed groups.

4. Possibly the tests used to measure resourcefulness are not valid or reliable, since they were set up solely on the judgment of the experimenter. (However, the author knows of no way of determining the validity and reliability of tests such as these.)

5. The practice periods were too short—only five weeks.

6. What is considered a No Practice Group really is not, since the subjects were drawn from science classes. Nor is the Laboratory Group purely a laboratory group, since it too originated in science classes where instruction is by demonstration. However, instead of detracting from the results, this enhances their value, for if, with only five weeks of laboratory practice, the group showed a marked improvement over a No Practice Group (which really had practice by demonstration), how much greater would be the improvement if the group had learned by laboratory work all along, and if the results were compared with a group which had really received no practice.

In the light of the limitations just mentioned, and assuming that the tests of resourcefulness in this study were valid and reliable, the conclusions of this experiment are:

1. Gaining experience by laboratory work seems to be a better means of developing resourcefulness than is gaining experience by watching demonstrations. This is based on the following results of the present study—

(a) The curves of resourcefulness of both Laboratory and Demonstration Groups are similar, except that the curve of the Laboratory Group is shifted further towards the upper range of resourcefulness.

(b) The Laboratory Group shows a greater advantage over the No Practice Group than does the Demonstration Group.

(c) If the entire group of sixty subjects is divided into quartiles, there are more subjects from the Laboratory Group in the upper quartiles than from the Demonstration Group. Just the reverse is true of the lower quartiles.

2. The relationship between resourcefulness and certain factors has been shown.

(a) *Intelligence.* Beauchamp and Webb claim that intelligence does not determine resourcefulness. This present experiment indicates a similar conclusion, if the correlation of the whole group is considered. But when intelligence and resourcefulness were correlated for each group separately, Groups I and III gave high positive correlations, while Group II gave a low negative correlation. No reason has been assigned for this unusual result.

(b) *Achievement.* Low positive correlations are found between resourcefulness and achievement in science as measured by science marks, and between resourcefulness and general achievement as measured by the average of all major subjects. Hence it may be said that achievement does not determine resourcefulness. Consequently resourcefulness cannot be used to predict success in science or in general school work. This conclusion agrees closely with that of Beauchamp and Webb.

(c) *Maturity.* There is no relationship between resourcefulness and maturity as measured by age or term in school. This agrees with Webb's conclusion that college students are no more resourceful than high school students.

(d) *Experience.* Beauchamp and Webb conclude that experience is the basis of all resourcefulness. In the present study, it is found that both groups which received experience by practice of one sort or another, did better than the No Practice

Group, which supposedly had no experience. Therefore this conclusion too may be said to agree with that of Beauchamp and Webb. However, it was found that practice by actually manipulating the apparatus led to a greater degree of resourcefulness than did watching someone else do so. This bears out a statement made by Meister in which he says, "Manipulative skills, resourcefulness, and facility in problem solving, can come most effectively from a teaching procedure which enables pupils to experience individually."[18]

3. This study has many obvious faults. Statistically, its conclusions may not carry much weight. Its value lies chiefly in the fact that it focuses attention on a question of current interest which needs solving, but at whose solution no adequate attempt has been made. Besides, it raises many other questions which subsequent research may solve.

Obviously, resourcefulness tests must be simplified and standardized. When this is done, larger groups of subjects of all kinds can be studied. The experiment just completed considered only small groups of girls of the first two years of high school. Other studies should deal with boys and mixed groups of all ages. The length of the practice period must also be extended so that the method of instruction used may have sufficient time to cause its maximum effect. Since the prevailing method of science instruction is a combination of both laboratory and demonstration, it might be worth while to study resourcefulness in a group receiving instruction by this combination.

Another important group of studies might deal with the question of transfer. Does resourcefulness in the laboratory carry over into life? Will the student who is highly resourceful in the laboratory also be highly resourceful when he leaves school and faces the problems of life? Or are the two types of resourcefulness unrelated?

Finally, there are many other factors which, like resourcefulness, may be unique to any one type of teaching or another. Before deciding in favor of one method, much additional work is necessary to discover and study these special aspects.

[18] National Society for the Study of Education, *Thirty-first Yearbook*, Part I. Bloomington, Ill.: Public School Publishing Co., 1932, p. 294.

# RADIO FADE-OUTS AND SOLAR ERUPTIONS*

DR. R. S. RICHARDSON

*Mount Wilson Observatory, Carnegie Institution of Washington*

In October, 1935, Dr. J. H. Dellinger of the National Bureau of Standards described several sudden and remarkable fade-outs of high-frequency radio transmission, affecting the daylight side of the earth and lasting for about fifteen minutes each. He suggested that these disturbances of radio might be connected with solar eruptions and asked that special efforts be made at the Mount Wilson Observatory of the Carnegie Institution to observe the sun continuously in order to see whether any unusual sunspot activity occurred at the time of the next fade-out, which Dr. Dellinger believed might be expected after an interval of about 54 days.

## THE OBSERVING PROGRAM

An examination of photographs showing the distribution of hydrogen and calcium in the sun's atmosphere, taken at Mount Wilson as part of the routine solar work, showed that on three occasions bright chromospheric eruptions had been photographed within a few minutes of the radio fade-outs reported by Dr. Dellinger. (The chromosphere or "color-sphere" is the scarlet-colored gaseous envelope encompassing the sun.) This agreement was so striking that special observations were planned

* Reprinted from *News Service Bulletin*, Carnegie Institution of Washington.

for several days before and after the date of the next predicted disturbance of radio transmission.

As already implied, one of the interesting features connected with the first four fade-outs was their occurrence at intervals of 53.4, 55.1, and 55.4 days, the mean being 54.5 days. This interval is twice the time it takes a point on the sun in latitude 16° to make a complete rotation, although the agreement may be only accidental.

The first observing program was accordingly set for the latter part of October, 1935. An eruption of moderate intensity was photographed on October 24, 54.9 days after the preceding fade-out and eruption. On October 10 the National Bureau of Standards noted a general improvement in radio transmission on the higher frequencies, which continued until October 21 to 23, when the upper limit of frequency reached the highest value the investigators had ever observed. On October 24, however, the upper limit dropped to half its value on the preceding days, and then, on October 25, returned to its previous high value.

A repetition of the phenomenon was expected about the middle of December. A brilliant eruption took place on December 16, 53.0 days after October 24, but no radio anomalies were noted on that date.

The next radio disturbance was expected about the middle of February, on the assumption that one should have occurred on December 16. This time observers were not disappointed, for a wide-spread fade-out occurred on February 14, 59.7 days following the solar eruption of December 16. Clouds prevented observations at Mount Wilson, but a bright eruption of major importance was seen at Greenwich about three hours before the fade-out. Whether later observations were made is not known.

Another fade-out and a bright eruption took place 54.1 days later, on April 8, and again on June 3, after an interval of 56.0

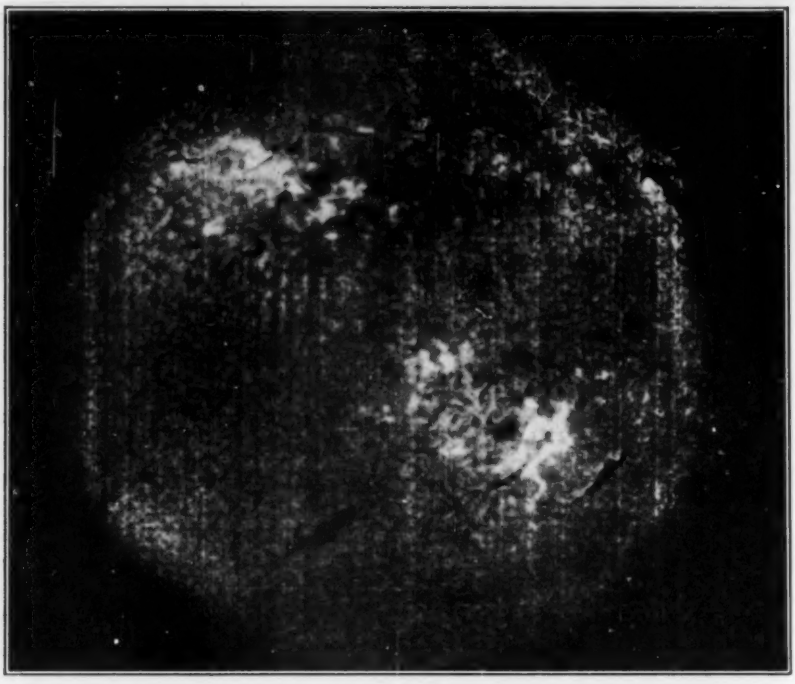

FIGURE 1.*

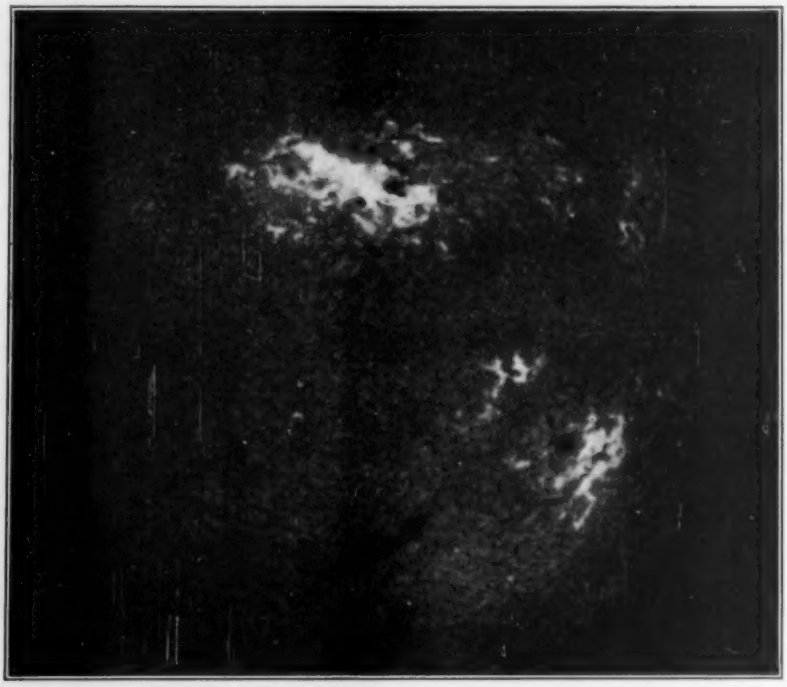

FIGURE 2.*

days. Although a minor fade-out was noted 53.0 days later, on July 26, the cycle evidently ended on June 3; at least the important disturbances of radio reported since then have not been in accordance with any simple and obvious law.

The observing program in October and December, 1935, and April, 1936, consisted simply in taking hydrogen spectroheliograms, showing the distribution of that gas, about every five minutes, unless interrupted by clouds or instrumental adjustments. Beginning in May, Dr. Seth B. Nicholson of the Mount Wilson Observatory installed a camera which takes spectroheliograms automatically on 35-mm. motion picture film. The interval between exposures is ordinarily about four minutes, while the actual time required for the image to pass across the slit and thus complete the exposure is about fifty seconds. The instrument is started soon after sunrise and operates continuously with very little attention until shut off about an hour before sunset. As a result, a nearly complete record of the appearance of the sun is available for all clear days at Mount Wilson since May, 1936. The data now accumulated are sufficient to permit interesting conclusions to be drawn.

## PROBABILITY OF RELATIONSHIP

Dr. Dellinger reports that from July, 1934, to June, 1936, thirty-nine fade-outs of high-frequency radio transmission have coincided so closely with observations of

*Figures 1 and 2 show a violent eruption of intensely luminous hydrogen gas from a great sunspot which occurred between January 23 (Figure 1) and January 24 (Figure 2), 1926. This sunspot (upper center of photographs) is the largest ever observed in modern times. A terrestrial magnetic storm of great intensity began 48 hours after the eruption. The isolated dark markings are solar prominences, masses of hydrogen extending thousands of miles above the general level of the sun's atmosphere. All the details appear farther to the right in the lower picture because of the rotation of the sun.

bright chromospheric eruptions that the probability of a relation between the two phenomena is very strong. Fifteen eruptions were photographed at Mount Wilson and are described here.

In five cases, the time when the eruption was first seen agrees to a minute or less with the time when the fade-out began. In all five cases solar observations had been made shortly before the fade-out occurred, the longest interval being eleven minutes.

About eight minutes are required for light to reach us from the sun. Hence if the *observed* beginning of an eruption were to coincide exactly with the beginning of a fade-out, it would seem highly probable that energy emitted from the solar eruption with the velocity of light was the direct cause of the fade-out.

The evidence to this effect is particularly strong for the disturbance on April 8, 1936. A spectroheliogram taken at $16^h\ 22^m$ (reckoning from midnight) was quite normal. The next plate, taken at $16^h\ 47^m$, showed that an unusually brilliant eruption had in the meantime occurred over a large spot-group near the central meridian. From the appearance of the bright flocculi (clouds of calcium- and hydrogen-vapor) and from previous experience with such eruptions, it was estimated that the outburst began only a few minutes before the exposure made at $16^h\ 47^m$.

This estimate was confirmed later by observations made at the Huancayo Magnetic Observatory in Peru, maintained by the Department of Terrestrial Magnetism of the Carnegie Institution. The observers at this station witnessed the eruption with the spectrohelioscope, noting the first signs of activity at $16^h\ 45^m$. A major fade-out was experienced at $16^h\ 46^m$, which lasted from 15 to 30 minutes for various radio frequencies.

### FURTHER INTERPRETATIONS

Six of the eruptions have apparently preceded the fade-out by from two to twelve minutes. The best example is that of August 30, 1935. A sudden fade-out took place at $23^h\ 20^m$. Examination of a series of exposures, taken every four minutes from $22^h\ 30^m$ to $23^h\ 30^m$, indicates that the eruption started as early as $23^h\ 0^m$, and at $23^h\ 8^m$ had become very intense. Here at least twelve minutes seem to have elapsed between the time the eruption was well under way and the beginning of the fade-out.

FIGURE 3.*

FIGURE 4.*

For the four remaining fade-outs, the observations at Mount Wilson were all made from ten to thirty minutes after the radio disturbance began, when eruptions were found to be already in progress. It seems probable that earlier observations

* Figures 3 and 4 show spectroheliograms of the hydrogen eruption of October 24, 1915. The lower photograph, taken 21 minutes after that above, shows that the smaller of the two sunspots has been completely obscured by the outburst.

would have shown the eruption occurring slightly before, or at the time of, the fade-out. No fade-out is definitely known to have preceded an eruption with which it was obviously connected.

Disturbances of the earth's magnetic field and chromospheric eruptions occurred simultaneously with the radio fade-outs on November 28, 1934, February 14, April 8, and November 24, 1936. The disturbances of the earth's field as recorded at Mount Wilson all consist of a sudden decrease of about 10 gammas in the horizontal intensity, accompanied by a change in declination of about 3′ toward the east.

These changes should not be confused with those characteristic of magnetic storms, which frequently last for several days, with fluctuations in horizontal intensity and declination often twenty times greater than those accompanying a radio fade-out. There is evidence that magnetic storms also may be caused by chromospheric eruptions, but with an interval of the order of 26 hours between the eruption and the commencement of the storm.

### FADE-OUTS AND BRIGHT ERUPTIONS

Spectroheliograms of the bright flocculi associated with radio fade-outs have been studied to see if they differ in any way from eruptions which do not coincide with known geophysical phenomena. The only distinguishing feature easily noted is that nearly all the eruptions producing fade-outs are much brighter than the average. On the scale of 1 to 3 adopted by the International Astronomical Union, six of the fifteen eruptions have been estimated to have been of maximum intensity 3, five of intensity 2, and four of intensity 1. Out of a total of 165 eruptions recorded at Mount Wilson from January 1 to October 31, 1936, only 7 per cent were of intensity 3, 24 per cent of intensity 2, while 69 per cent were of intensity 1.

The mean latitude of the eruptions is the same in both hemispheres, namely 23°. The eruptions have thus far shown no definite tendency to favor any particular location on the sun or any special distance from its central meridian. It has long been known, however, that very intense magnetic storms are more frequent when large active spot-groups are near the central meridian.

This circumstance is naturally explained if we may assume that radio fade-outs are caused by radiation, and magnetic storms by charged particles ejected radially from sunspots with a high velocity. Radiant energy reaches the earth regardless of where it originates on the disk, but a stream of charged particles is not likely to encounter the earth unless ejected from a spot near the central meridian.

### ERUPTIONS NOT DUE TO HIGH TEMPERATURE

The radiation producing the fade-outs seems undoubtedly to come from the outbursts that show so conspicuously on hydrogen and calcium spectroheliograms. A natural assumption would be that a small area on the sun, at exceptionally high temperature, emits a great amount of blackbody radiation of high frequency; but direct observational evidence shows that this assumption is untenable.

For many years the spectroheliograms at Mount Wilson were taken with two slits set about 5 cm. apart—one over the $H\alpha$ line of hydrogen or the K2 line of calcium, the other over some part of the continuous spectrum. Two images were thus obtained simultaneously: one showing the distribution of the light of hydrogen or of calcium, the other resembling a direct photograph of the sun but made with light of a single color.

In the course of the routine solar observing we have by chance photographed many bright eruptions. If these eruptions were

associated with black-body radiation of high temperature, they should also have shown conspicuously on the monochromatic images taken at the same time. An inspection of many plates recording violent hydrogen and calcium eruptions fails to show any trace of a corresponding image on the photographs made with the continuous spectrum.

These observations indicate that fade-outs are not caused by any increase in radiation of the kind associated with a great increase in temperature.

The question naturally arises why certain eruptions produce radio fade-outs while others do not. It is suggested that possibly the condition of the ionosphere, in addition to radiant energy from the sun, may be a factor in determining whether or not a fade-out of high frequency radio transmission occurs.

## AN IMPORTANT DISCOVERY*

A new and potent weapon to combat the epidemics of measles that periodically sweep the country and that have made it the most common of the communicable diseases, the most dreaded of childhood ills, was announced on November 7 by Professor Jean Broadhurst, bacteriologist at Teachers College, Columbia University. Professor Broadhurst reported that she had found a way to make visible the virus bodies that cause measles, thereby making it possible to determine the presence of the disease even before the characteristic rash appears.

Her discovery will enable doctors to detect and quarantine cases of the measles two or three days earlier than usual and lessen proportionally the chance of infecting others. At the same time it opens the way to control by vaccines, since researchists will now be able to see and study the virus bodies, something that has been impossible heretofore.

Professor Broadhurst was aided in her discovery by Dr. Margaret Estelle McLean, research assistant at the college, and by Vincent Saurino,,a student. Her experiments were carried on under a grant from the Milbank Memorial Fund. They are described in the current issue of *The Journal of Infectious Diseases.*

Previous attempts to demonstrate in the nose and throat the virus bodies that cause the measles had failed because the stains commonly used also colored the numberless bacteria which are normally found in the nose and throat, where the virus bodies lurk. The result, according to Professor Broadhurst, was, naturally, to make the virus bodies indistinguishable from the microbes.

The problem that faced Professor Broadhurst, therefore, was to find a stain that would color the virus bodies, without, however, affecting the microbes. Nigrosin, a simple, black ink-like liquid that had long been known to bacteriologists was the stain that met these requirements.

The stain is commonly used on general cells, Professor Broadhurst declared, but not on microbes because it colors them only slightly if at all. It was this very inadequacy that recommended it to Professor Broadhurst. She decided that nigrosin might stain the virus bodies as well as general cells, and experiments showed that it did.

In describing her discovery, Professor Broadhurst declared that it will make it possible not only to discover and quarantine cases of the measles two or three days sooner than at present, lessening the transfer to others, but, more important still, to detect carriers—people who carry the virus bodies about with them, infecting others, yet who are themselves immune to the disease.

*Release Teachers College, Columbia University.

# Classroom Notes

**Other useful plants for biology teachers.*** —The following species are described in Gray's New Manual.

*Elodea canadensis* Mchx. Water Weed. *Hydrocharitaceae.* This plant is a common inhabitant of laboratory aquaria, and will grow luxuriantly there if the animal life is otherwise well fed. Under the microscope, its leaves are studied for cell structure, circulation of the cytoplasm, and plastids. The terminal bud when carefully dissected out makes a beautiful microscopic demonstration. A classical use has been in experiments demonstrating the liberation of oxygen during the process of photosynthesis. A clear cut demonstration in this case requires strong sunlight and an abundance of $CO_2$ in the water, introducing the latter if necessary.

*Lemna* sp. Duck Weed. *Lemnaceae.* This little plan is often brought in with other aquatic plants, and under the microscope, the leaves show the positions taken by the chlorophyll grains under illuminations of various intensities. The water roots have root pockets—not root caps.

*Tradescantia virginiana* L. Spider Wort. *Commelinaceae.* In the western part of the United States it is probable that this plant can be replaced for the purposes indicated by *Zebrina* sp. The flowers are produced throughout the summer but sometimes it can be brought into earlier bloom. The staminal hairs show cytoplasmic strands and the circulation of the cytoplasm. Excellent sections may be made of its simple leaf which is also good for the study of stomata. The leaf cells may be used in plasmolysis experiments while those of the stem exhibit groups of raphides. The root may be longitudinally sectioned to show root cap, dermatogen, periblem and plerome.

*Opuntia vulgaris* Mill. Prickly pear. *Cactaceae.* Leaves reduced to small thorny protuberances; the stem (phylloclade) assuming their function. Idioblats resembling tracheids, and functioning as water reservoirs, are found between the chlorophyll containing cells in some of this family. Stems fleshy; serving in a storage capacity. As is well known, these plants are capable of surviving unusually harsh conditions and hence suggest a source of experimental material for students. Species of *Mammillaria,* the globose or ovoid type of cactus may also be represented in the laboratory. Ornamental.

*Myriophyllum* sp. Water Milfoil. *Halorigadaceae.* Useful as an aquarium plant. Under water, the leaves are finely divided. A section of the stem shows air canals.

*Utricularia* sp. Bladderwort. *Lentibulariaceae.* While this form also has a place in the aquarium, its chief interest for us is in the elaborate little bladders which not only float the plant at the time of flowering, but serve to capture small animals which are unable to escape. Thus we have a carnivorous aquatic plant which can be demonstrated under the microscope.

*Cycas revoluta* Thunb. Cycad. *Cycadaceae.* Is fairly resistant to laboratory conditions and is also ornamental. The possibilities of terraria and Wardian cases for growing species of plants which may be required for specific purposes should not be overlooked. Mosses and liverworts may be brought along in this way. Chamberlain[2] gives concise directions for the culture of many of the lower aquatic plants. Included are the *Chlorophyceae—Nitella* and *Chara* useful in showing protoplasmic movement; many of the algae usually studied in the laboratory in a living condition; prothallia of *Equisetum,* and heterosporous Pteridophyta such as *Marsilea* and *Isoetes.* The experimental possibilities of such cultures further enrich the instruction.

N. M. Grier,
*Myerstown, Penna.*

**Collecting equipment for the biology teacher.***—*A. Dip Net:* A sturdy dip net can be made by bending #5 bronzed market wire to form a circle of about ten inches diameter. Bend the two ends so that about three inches of one and four inches of the other will be at right angles to a tangent of the loop, forming ears for the attachment of the hoop to the handle. (See Figure 1.) The last quarter inch of each ear should be bent so that when the wires are crossed to make a closed circle, the tips will point slightly inward into the handle. (Figure 2.) Spring wire metal may be substituted for market wire, but it will require special tools for bending.

The wire hoop may be attached to a hayfork or rake handle. The ends of these handles are hollow for a few inches from the tip. Remove all but half an inch of the hollow tip and cut the remaining portion with a rip saw to make a wedge shaped groove to receive the overlapping wires of the hoop. The distal portion of the groove should be approximately the width of the wire, but the basal portion is double that width.

[2] Chamberlain, Charles J. "Methods in Plant Histology." University of Chicago Press.

* Continued from page 159, October, 1937, issue.

* Continued from page 100, April, 1937, issue.

FIGURE 1.—Hoop construction, open.

This channel accommodates the double portion of wire which closes the hoop circle at the handle.

A lengthwise furrow is made on each side of the handle to allow the attachment ears of the hoop to lie firmly in place without extending much above the surface of the handle. One furrow is three inches in length, the other four inches to correspond to the length of the ears. At the end of the furrows a deeper hole is made to receive the inward bent tips of the ears.

The ends or ears of the hoop may be fastened tightly into the handle by encircling with common hose clamps. These are pliable bands of metal with a bolt through the ears for tightening the clamp.

Figures 3 and 4 will illustrate the details of construction of the hoop and handle construction.

The net is made of cable marquisette (coarse curtain cloth) cut into a bowl shape. Marquisette is so woven that woof threads will not slip on the warp. Therefore it is preferred to cheaper cloths in which pulling of threads produces holes. This net may be attached to the

FIGURE 2.—Hoop construction, closed by overlapping the ends.

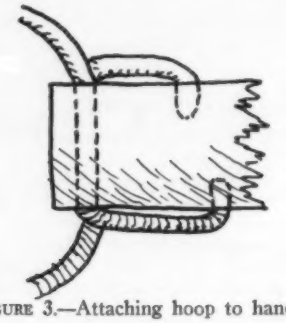

FIGURE 3.—Attaching hoop to handle.

hoop by sewing it onto a narrow strip of canvas which forms a protective curtain over the wire hoop.

*B. Insect Net:* The terrestrial insect net is of lighter weight than the aquatic nets. For this purpose a market wire hoop with diameter of 12 to 15 inches may be attached to a light weight

FIGURE 4.—Hoop attached to handle.

mop handle or broomstick. The netting is of French marquisette (fine mesh curtain material). This cloth should be cut to form a deep conical bag with a length 1½ times the diameter of the hoop. The greater depth in this case allows the tip of the net to be swung over the rim of the frame to close the bag. The net is attached to the frame by a narrow protective strip of canvas or heavy muslin.

The ordinary folding type of fish dip net provides a more convenient frame for the insect net. The advantage of this frame is that it may be collapsed into a compact, inconspicuous bundle about two feet in length. The bag is constructed of French marquisette as in the case of that just described above.

LESLIE BERGEN,
*Univ. of Minnesota High School*

# Editorials and Educational News

## COMRADES IN RESEARCH*

Admission into this Society is a simple but serious ceremonial, celebrating your acceptance for fellowship in exploring enterprises within the realms of science. This initiation thus becomes a moment of self-analysis and self-direction in relation to those personal qualities of power, endurance, vision and trustworthiness, which are essential for a happy companionship in a life-time venture. It is, therefore, meet that we should take an inventory of the most salient personal requirements for this high order of companionship and responsibility.

You have been selected primarily on evidence of intellectual curiosity, some degree of creative imagination, and a natural and sustained urge for asking questions of nature. These gifts in one person are comparatively rare and are to be highly treasured and cultivated by those who possess them. They are the criteria by which it will be determined for each of you whether you shall continue as a comrade in research or fall by the way-side. The present selection is not infallible; it merely represents an opportunity to prove your worth and seriousness of intention.

As investigators, you will be called upon to show the power of painful vision into the unknown on the basis of established observation points in the known, to persist in untiring effort in the face of towering obstacles, to see the goal of the group with which you are associated, to take your own assignment for leadership in the division of labor, and to exercise those habits of intellectual honesty which are *sine qua non* in the search for truth.

The explorer in any field, physical or mental, needs red blood, a good stomach, firm muscle and balanced endocrines. It is the duty of one who joins a field party to keep himself fit. The fact that many of those who have achieved in the past have succeeded in spite of the neglect of physical health is no justification for any young investigator to take the risk.

Indeed, the recognition of the possibilities and the significance of physical fitness is an achievement of modern science. It is a matter of intelleetual economy. The scholar is now not only expected to show good judgment in regard to matters of physical health; but, in the culture of today, the maintenance of health has become a moral question. There are two kinds of suicide: one where the individual snaps out his life in a moment, the other where he spills it gradually in defiance of reason and morals pertaining to health. The intensive researcher must work hard, but he must also master the art of loafing for relaxation.

There are three tap-roots which furnish the vitality and drive in a man's life; namely, the tendencies for the perpetuation of the species, the perpetuation of the individual and the perpetuation of the social group. The last is a comparatively late acquirement in the process of evolution and is most in demand in the higher human pursuits. Unselfishness, the willingness to share in labor and the fruits thereof, and the ability to cultivate the welfare of associates in action, is given a most severe test in the field of scientific pursuits. Broad horizons, cultured sympathies, and the spirit of sacrifice count much in intellectual expeditions. "Laboratory rat" is justly a

* Editor's Note:—Dr. C. E. Seashore has generously permitted us to publish this charge which he, as an older member of the staff, made upon request to the initiates into Sigma Xi at the University of Iowa during the last academic year.

term of scorn for the investigator whose social life is rat-like.

The products of research constitute wealth and there are peculiar moral requirements which must become fixed habits in the pursuit and hoarding of this type of wealth. In research, as in ordinary-life morality, the problem is not that of complying with ordinary rules and sanctions, but rather a sense of joy in living and the cultivation of intellectual generosity and integrity in applying the findings of science to life.

The beautiful life is our goal. The sense of beauty which puts the investigator *en rapport* with nature in wonder and awe is a priceless gift to the investigator and his associates. Whether he turns to the micro-organism in the dirty water below, to the macro-organism in the star-filled skies above, or to the manifestation of the power of mind within himself, he encounters beauty. Aesthetic insight, based upon the laws of nature, is a precious jewel in the scientific mind.

Religion has done much to block science; but, in the long run, it has been a moulder of the finer traits in the scientific mind, which may be described in part in religious terms, as an attitude of reverence for and a fellowship with those forces in and above nature which are manifested in the progressive realization of truth, goodness and beauty.

As you accept our hand of fellowship, you also enter into a higher order of relationship, fellowship with the sages of the world, as revealed in the history of science. Learn from them, love them, and live with them as your comrades.

C. E. SEASHORE,
*University of Iowa.*

## WHAT SHOULD BE THE PLACE OF SCIENCE IN EDUCATION

The April, 1937, issue of *Science Education* contained paired articles by representatives of the natural and social sciences which set the author thinking of the problem above. The problem has been developing through the reading and attempts to interpret the prefaces of textbooks of science, and the textbooks and articles on science teaching most emphasizing science as classified knowledge and method; a series of articles in *School Science and Mathematics* on: "Is This the Scientific Method?"; attendance at meetings of science teachers and teachers of science teachers. The result has been confusion due to the difficulty of reconciliation of the ideas presented in the name of science with methods of presentation and practical application.

Before the question can be answered, even tentatively, the meanings assigned to "Science" and "Education" must be stated. Broadly, the latter may be thought of as a process by which an individual may be prepared to join positively, productively and appreciatively in the social environment in which he may find himself. Science is usually thought of as organized (usable) knowledge of the natural environment and the method by which that knowledge was obtained and organized. Analysis of the latter feature leads to the conclusion that it is nothing more than that uncommon "commodity," common sense.

Mr. Riddle has made out a good case for the value of the knowledge side of natural science in education. It would be interesting to determine, if possible, what fraction of adults who have "learned" science in high school have experienced any educative change as a result of that learning. For example, what fraction having "passed" biology have developed an understanding of life processes or modified their living habits as a result; or, having passed physics, have a real concept of the energy changes in an operating automobile with resultant more intelligent driving. The answer to be expected would be probably, "A very small fraction." But are the examples given biology and physics respectively? Certainly they are not abstract biology and physics. They are, however, classified, possible educative outcomes and

where better can they be obtained than in those respective study fields? Many sicence teachers apparently expect students to reach these and similar ideas unconsciously.

Many articles during the past ten years have dealt with major generalizations of science to be obtained from science courses by students. These, in many cases, have been taught for many times ten years by texts and teachers without high educative effect on the average student in general. In answer to the query, "Why?" the suggestion is made that the student has accepted the statement usually as a desirable bit of impersonal knowledge useful, if at all, for examination purposes. This suggestion must occur to anyone who has taught and intelligently observed average students who generally seem interested in knowing what the teacher wants them to know. The degree of knowledge will be determined at test time. Hence the impersonal attitude of the average student of the average teacher.

But this is not education. It is training of a sort to lead to unquestioning acceptance of statements proposed as ideas by associates and involves no intelligence other than that involved in memorization. If all courses in all departments are taught thus can we expect that, through schooling, we can educate for positive, intelligent social action? Habits develop through exercise and here is no opportunity for exercise of intelligence applied positively and productively.

An implication of general unintelligence is not to be gathered from the foregoing, for most individuals judge indicating intelligence but judge emotionally rather than intelligently on a basis of proved ideas. In the classroom it seldom happens that a student questions the validity of statements made by his teacher or textbook. One notable, depressing fact is the lessening of the questioning attitude among upper classes of high school and college, implying a lessening in activity of intelligence with increasing exposure to academic contacts. This gives the idea that schools generally train to attitudes of acceptance and contradicts the generally held concept of independent Americanism.

If the above conclusions are at all valid the obvious problem develops, "What, if anything, can be done to develop an educative system in the schools?" One answer is that education be directed toward usable knowledge of the environment through understanding of sources and relationships between items of that usable knowledge. Here is opportunity for use of the method side of science directly or indirectly. Most science valuable to the average man in his environment is non-mathematical and phenomenal. What he needs is an understandstanding of causes and relationships of, and between, phenomena, useful explanations of those causes and relationships in order that he may use them again in different situations. But the way to learn to explain is to explain again and again as one will need to explain. This leads to the suggestion that much of our scientific knowledge be obtained scientifically. (It must be obvious that most textbooks of science as well as most textbooks are not scientific in method of statement although usually logical in organization.) This means that the knowledge must be developed not accepted, for science never accepts blindly. In science teaching this will eliminate immediately many topics usually included in our courses and emphasize others.

The inductive approach to the solution of problems offers unexcelled opportunity for the creation, from the student's viewpoint, of generalizations. He arrives at them through his own thinking and they are his. Students thus reaching ideas are often surprised to find they have learned, by their own thinking, something which can be found in their textbook, as perhaps it originally reached the printed stage. This requires no acceptance, no study of the teacher's ideas; rather it gives a conception of how much authentic knowledge has been attained and an increasing tendency to

look into the sources of other knowledge. With practice of this apparently independent method of obtaining knowledge the pupil will feel a growing sense of reliance on his own thinking processes which should carry over into other fields.

Properly chosen problems involving either inductive or deductive approach, or both, will call for laboratory study for obtaining data to validate suggestions, in other cases may definitely motivate a class experiment or "demonstration." Through these types, intelligently directed by the teacher and followed by the student, the student will have opportunity to practice and acquire certain scientific attitudes such as basing judgment only on data, suspending judgment, perhaps changing opinions to fit the facts and others. These are all desirable in other fields than science.

The writer has found the use of objective questions for assigned problems definitely helpful in learning with understanding and developing desirable attitudes. True-False, Multiple-Choice, each choice having some connection with the problem, Fact-Theory and Cause-Effect[1] types may be used with the requirement that a scientific validation of the conclusion made be given. In arriving at a true choice the student must have a clear understanding of the necessary principles. With insistence upon validation of statements made on paper and in class discussion an attitude demanding proof for ideas, including those presented when necessary by the instructor, develops. Data exist to prove this statement. Evidence also exists of definite carry-over of this attitude into other departments of instruction by the students and into their teaching by teachers in extension courses.

Some of the suggestions made here can be used in other fields than sicence teaching. However science represents the field which can offer definite method and data most completely. It would appear most desirable for complete education that all educated individuals, except in countries of dictators, should possess the attitudes listed earlier. Study of sicence, scientifically, can give both the usable knowledge necessary in this age of science and, perhaps more important, the attitudes and habits of thinking necessary in this age of social unrest.

CARLETON E. POWERS,
*State College for Teachers,*
*Albany, N. Y.*

[1] Davis, Ira C. "The Measurement of Scientific Attitudes." *Science Education* 19: 117–122; October, 1935.

## REPORT OF MEETING OF THE AMERICAN SCIENCE TEACHERS ASSOCIATION, ATLANTIC CITY, NEW JERSEY, DECEMBER, 31, 1936

A report of the Atlantic City meeting of the A. S. T. A. was published in a February number of *Science*. Dr. Conklin's luncheon address is published in the February issue of *Science Education*. Some of the papers given at the meeting were published in the April number of *Science Education*.

The meeting at Atlantic City was very well attended. Many of those present stated that it was one of the most outstanding science teachers' meetings they had ever attended. Credit for this is due very largely to Dr. Morris Meister, who is vice-president of the A. S. T. A., and who planned and directed the meeting.

The next annual meeting of the A. S. T. A. will be held in Indianapolis on December 30, 1937. I hope every one who is able will attend that meeting. It should be the largest and most worthwhile meeting of any we have had.

The officers elected for the ensuing year are as follows:

*President*—Harry A. Carpenter, Rochester Schools, 501 Genesee St., Rochester, N. Y.

*First Vice-President*—Earl R. Glenn, State Teachers College, Montclair, N. J.

*Second Vice-President*—Jerome Isenbarger, Wright City Jr. College, 3400 N. Austin Ave., Chicago, Ill.

*Secretary*—Harry A. Cunningham, Kent State College, Kent, O.

*Treasurer*—Homer W. LeSourd, Milton Academy, Milton, Mass.

*Directors-at-large:*

Morris Meister, Haaren High School, 59th St. and 10th Ave., New York City.

G. P. Cahoon, University School, Ohio State University, Columbus, O.

W. J. Klopp, Supervisor of Secondary Education, Long Beach, Cal.

Otis W. Caldwell, Boyce Thompson Institute, Yonkers, N. Y.

To date, the following local science teachers' organizations (with a total membership of several thousand) have voted to affiliate with the A. S. T. A. Their delegates to the Board of Directors of the A. S. T. A., in so far as they have been selected, are given:

Chemistry Club of New York City.

General Science Association of New York City.

N. A. R. S. T.

Delegate—Mr. Hanor A. Webb, Peabody College for Teachers, Nashville, Tenn.

Nebraska State Science Teachers' Association.

New England Biology Teachers' Association.

Delegate—Mr. Malcolm D. Campbell, President, New England Biology Teachers Association, Highland St., Milton, Mass.

New York State Science Teachers' Association.

The Physics Club of New York.

Texas State Science Teachers' Association.

Delegate—Dr. Don O. Baird, Sam Houston State Teachers, Huntsville, Texas.

There are four very important problems to be carried out as far as possible during the present year. They are:

1. It is hoped that every individual member and every interested science teacher will see that the question of affiliation of their local organizations with the A. S. T. A. is considered at the first opportunity. It is expected that many of these organizations all over the country will desire to affiliate. All are invited.

2. We have several independent and very valuable journals for science teachers. However, it seems as though none of these is able to meet adequately all the needs of classroom teachers throughout the country. One objective of the A. S. T. A. is to promote the development of either an existing journal, or a new journal, which will more adequately meet a larger number of needs. The only practical way in which this can be done is to obtain a larger circulation. The A. S. T. A. will have a membership large enough to warrant the frequent publication of a journal at a price within ready reach of every teacher's pocketbook. Won't you, therefore, canvass the situation among your local teachers, and send in any comments pertinent to this problem.

3. We have a complete transcript of the meeting and discussions presented at Atlantic City. It is hoped to make this available to every teacher who desires the same. If we have call for as many as five hundred, we can supply them for about 45¢, which includes cost of mailing. On the other hand, if we can use a thousand or more, the cost will be reduced to 30¢. Won't you, therefore, fill out the enclosed slip, indicating the number of copies that you and your associates would like at the 45¢ price, and the number you would want if the price were 30¢. It would seem likely that we shall require at least one thousand copies. However, we must know your wishes in the matter promptly.

4. According to the constitution, individuals are eligible to membership in the A. S. T. A. by the payment of an annual fee of $1.00. On the other hand, teachers who belong to affiliated organizations will have no individual membership fee, inasmuch as their directorship fee of $5.00 per director will entitle them to all privileges. This need not mean, however, that members of affiliated organizations may not join as individual members as well. In which case, they should remit their $1.00 to the treasurer. The money will, of course, be useful. Attached hereto is a slip which you may use for this purpose.

Cordially yours,

HARRY A. CARPENTER,
*President*

## NATIONAL FRESHMAN PLACEMENT TESTING PROGRAM

The American Council on Education announces an expanded program of placement tests for 1937 as a development of its Cooperative Test Service. The new program is intended to give college guidance officers means of appraising abilities of entering freshmen. In the field of science, tests are available for Physics, Chemistry, Botany, Geology and General Science. An advisory service is a special feature of the program. A leaflet describing the program may be obtained by addressing Cooperative Test Service, 439 West 59th Street, New York City.

# Abstracts

## SECONDARY SCIENCE

MOODY, F. W. "Portable Units for Physics Demonstration." *School Science and Mathematics* 36: 774–980; December, 1936.

Every teacher of physics will find valuable these careful and complete directions for the construction and use of a number of important pieces of electrical instruments and devices. —F.D.C.

NUTTING, J. MORLEY. "Weather." *School Science and Mathematics* 36: 733–742; October, 1936.

This careful and complete description of "a series of class demonstrations in connection with the teaching of weather," presents a number of ingenious teaching devices which will prove of interest and value to all teachers of general science. —F.D.C.

CARLETON, R. K., AND INCE, J. W. "Lessons from Twelve Years of Chemistry Contests." *Journal of Chemical Education* 13: 464–468; October, 1936.

This report describes a chemistry contest held at Rhode Island State College every spring in connection with the annual interscholastic track meet. High schools are invited to send teams of three to five students to enter this contest. Awards are made on the basis of the three highest scores made by each team. The tests used are largely objective and the results are announced on the afternoon of the same day on which the contest is held. These contests have been of value to the Department of Chemistry which conducts them, in helping them to devise and evaluate various types of examination questions, and to discover weak places and strong points in the preparation of high school pupils in chemistry. They have been especially valuable also for the interest developed in chemistry and in the college, on the part of those who entered the contest.

—V.H.N.

WAKEHAM, GLEN. "Some Devices for Combatting Verbalism in the Teaching of Elementary Chemistry." *Journal of Chemical Education* 14: 65–67; February, 1937.

In this article "verbalism" is defined as repetition without satisfactory understanding of the words of a textbook by the student. It is suggested that having students supply their own illustrations of a principle or law, visualization of problems in concrete terms, decrease in emphasis upon carrying out arithmetical computations to needless and meaningless extremes, and use of problems involving more than one related law will help to increase understanding and thereby help to eliminate "verbalism."

—V.H.N.

DEWITT, CHARLES B. "The Household Comes to the Laboratory." *Journal of Chemical Education* 13: 577–580; December, 1936.

A terse article giving laboratory uses for many household articles which serve these purposes as well as, or better than, those which can be purchased from scientific supply houses. A mine of helpful information for any teacher of chemistry and particularly valuable for the teacher who has little laboratory equipment.

—V.H.N.

PALMER, FREDERICK. "The Helpfulness of Objective Tests in Physics." *Journal of Chemical Education* 14: 108–114; March, 1937.

The chief weakness of the College Entrance Examinations is their subjectivity, which results in wide variations in difficulty from year to year, assuming that the evaluation of these papers is statistically reliable. The author points out the advantage of objective tests in physics and presents data based on the use of the Cooperative Tests in College Physics. These include information on the variation in achievement among institutions, the effect of high-school physics upon achievement in college physics and other interesting facts. —V.H.N.

HALL, ALTON L., *et al.* "The New Assistant." *Science Leaflet* 10: 33–39; February 11, 1937.

This is a science play given by Sigma Omicron Sigma science club of the Atlantic City High School during the 1936 convention of the Metric Association. —C.M.P.

## TEACHING OF SCIENCE

PRESTON, CARLETON E. "The Science Column." *The High School Journal* 7: 245–248; November, 1936.

Mr. Preston raises one of the most significant questions facing science teachers today. Science teachers have assumed that:

. . . to bring students to an understanding of the major facts and principles of science was sufficient to develop in them, at the same time, those habits of accurate observation and, still more, of keen-minded interpretation and sound judgment that are not only characteristic of the scientist at his best, but also generally essential to independence of thought and to intelligent citizenship under a democratic form of government. . . . More and more

these have come to realize that, fine as is the mere understanding of facts and principles, what counts still more is the acquiring, in addition, of the habit of applying these facts and principles intelligently in daily life. Valuable beyond these, too, is the habit of investigating, in the careful manner of the scientist, all sorts of problematic situations met in life, and the ability to reach, through safeguarded thinking, tested conclusions or generalizations concerning them that may serve as guides for subsequent action. . . . It is furthermore important that this ability, and this habit, be extended to function beyond the realm of the natural sciences, for many of our most pressing problems today lie in social and economic fields. The development of all these qualities, it is now realized, depends not chiefly upon the subject matter, but upon the treatment accorded to it by the teacher. . . . Laboratory work came to be measured less in terms of student growth in powers of thought, and more in terms of time and quantity units. . . . Today we are beginning to realize more and more that the emphasis should be the other way round. This does not mean, of course, that we should ignore the value of scientific knowledge expressed in terms of facts and principles, but that we should lay the greater stress upon gaining the ability both to achieve and to use such knowledge independently. In other words, we have come to appreciate the need of cultivating in our students the *mental habits* of the scientist as greater than that of passing on to them the *accumulated knowledge* now possessed by scientists. . . . Now, such teaching, if practised consistently and continually, is very time-consuming. . . . Science teachers, then, are today faced with a very serious problem —the problem of deciding whether to sacrifice the presentation of a well-rounded survey of a science field, such as most of us have been trying to give, to the time demands of a type of teaching such as has just been described, in which content must be largely incidental and fragmentary. There is surely not time to do credit to both types. Up to now, say what we will to the contrary, our emphasis has been on content first; our courses have been determined by syllabi, workbooks, and texts all laid out on a content basis; and college entrance or other final examinations have been fundamentally of content type.

When one prepares to use any one of the recent texts in any of the secondary school sciences, he is immediately confronted with the necessity of making the choice outlined by the above excerpts from Mr. Preston's article. Mr. Preston illustrates his point by showing how a traditional formal physics exercise may be used to develop the type of outcome desired. The reviewer agrees with Mr. Preston in his final statement that "the question is the most fundamental one that faces science teachers at the present time."

—O. E. Underhill.

PRESTON, C. E. "The Science Column." *The High School Journal* 20: 25–28; January, 1937.

Mr. Preston has analyzed a group of student answers to science questions on the basis of their structure with regard to logical reasoning rather than their content. He states five things which one should expect to find in a reasoned answer. The students' answers to questions are then discussed in the light of these criteria. This seems to be a fruitful approach toward the problem of directing science teaching so that the methods of the scientist rather than mere accumulation of facts may be emphasized. —O. E. Underhill.

PRESTON, C. E. "The Science Column." *The High School Journal* 20: 58–60; February, 1937.

This discussion gives some very good advice to those individuals who may be attempting to organize programs at conventions or other meetings for teachers of science. To the reviewer the most significant suggestion is to avoid too many speakers on the same program. Other helpful suggestions are given as to the qualifications an individual should have for various kinds of addresses.

—O. E. Underhill.

LEVELL, J. M. "Visual Instruction Project in Laboratory Chemistry." *The Educational Screen* 16: 39–40; February, 1937.

Proper laboratory technique is the major objective of the project described in this paper. Pupils and teacher together seek to contrast correct with incorrect laboratory techniques by photographing both and preparing lantern slides for the benefit of the whole class from the negatives. Twenty such subjects are described. Suggestions as to proper lighting and grouping for effective results are given. —B.C.H.

EMMERT, WILBUR. "How To Construct and Use Star Maps." *The Educational Screen* 16: 162–169; May, 1937.

This very helpful article aids not only in learning the positions of the stars and constellations, but also those unmarked lines and points on the celestial sphere such as the ecliptic, celestial equator and equinoctial points. We are all familiar with the use of a guiding line through the pointers of the big dipper to locate the north star. The use of such lines in order to show relationships of stars and constellation groups is effectively used in numerous other instances in the charts suggested in this article. Useful suggestions are given as to methods of preparing and using these charts as part of the class procedure.

—O. E. Underhill

FRANCIS, THOMAS. "The Laboratory Shop in the Small Rural High School." *The Phi Delta Kappan* 19: 257–260; April, 1937.

This issue of the *Phi Delta Kappan* is devoted to the problems of the small school. This article describes a combination science and shop set-up. It includes a science room, wood working and general shop, and automotives shop.

—O. E. Underhill

Anonymous. "Smashing Atoms." *Popular Mechanics Magazine* 67: 321–325, 158A; March, 1937.

Some of the newer theories of atomic structure resulting from recent investigation into the nuclei of atoms are presented. Pictures of models representing various atomic and electron arrangements are helpful. —O. E. Underhill

HOFF, A. G. "A Test for Scientific Attitude." *School Science and Mathematics* 36: 763–770; December, 1936.

This report of an investigation in the measurement of the scientific attitudes represents a substantial contribution toward the solution of this important problem in the teaching of science. A

test of two hundred items measuring the various scientific attitudes is made the instrument of measurement in a learning study with more than three hundred twelfth-grade students in four high schools. —F.D.C.

COMPTON, KARL T. "Science in an American Program for Social Progress." *Scientific Monthly* 44: 5–12; January, 1937.

"That our national health, prosperity, pleasure, and indeed our very existence depend largely upon science for their maintenance and their future development, no informed person would deny. We have reached the point beyond which further increase in our wealth, population, physical comfort and cultural opportunity will depend not on discovering new resources by geographical exploration but by wiser use of the resources we now have, through scientific exploration." Dr. Compton believes the idea quoted above marks a turning point in the history of the world. Through the agencies of government, industry and education science can be made to contribute effectively to the social progress of America. —C.M.P.

## COLLEGE SCIENCE

FRUTCHEY, FRED P. "Evaluating Chemistry Instruction." *Educational Research Bulletin* 16: 1–6; January 13, 1937.

After listing some fourteen objectives of chemical instruction the author points out the limitations of pencil-and-paper tests in evalutating achievements of some of the objectives enumerated. "A comprehensive evaluation program calls for a variety of methods for collecting evidence of growth." The correlations of success in information tests with tests of ability to draw inferences or application of principles are low. A single score is not an adequate index of a comprehensive picture of a student's growth. Uses, four in number, are advanced for making attempts to evaluate the outcomes of chemical instruction. The reader is told how to clarify objectives with the purpose of measuring the extent of their achievement by examinations. The usefulness of anecdotal records in appraising a student's progress toward habitual demands for evidence before decisions are made is suggested. Indirect evidence of student success in attaining the objectives of chemistry is offered as a means of improving the adequacy of the sampling. However, such indirect test forms are not considered acceptable until their high correlations with the more direct form are established. Illustrations of methods used in securing such correlations are presented. —B.C.H.

MUNRO, L. A. "The Place of Colloid Chemistry in Chemical Education." *Journal of Chemical Education* 13: 457–463; October, 1936.

A questionnaire was sent to 118 colleges and universities in the United States and Canada which give graduate work in chemistry or chemical engineering, asking for certain facts about a separate course in colloid chemistry. Seventy-three institutions reported 82 courses in colloid chemistry. The courses are most often given in the fourth or fifth year as electives. In about half the courses there is no laboratory work or it is elective. In thirty of the courses catalysis is dealt with. There is evidence in this survey of a tendency towards establishment of courses in colloid chemistry separate from the usual courses in physical chemistry. —V.H.N.

GILBERTSON, L. J. "A Study of Student Results in Qualitative Analysis." *Journal of Chemical Education* 13: 483–484; October, 1936.

This report summarizes student reports of 18,678 cation and 4,073 anion tests over a period of seven years. There is clear evidence that ions are not at all equal in difficulty of identification if present, and that some are much more likely to be reported than others, when not present. The author maintains that these facts should be taken into careful consideration in grading students in qualitative analysis. —V.H.N.

FILLINGER, HARRIETT H. "Some Departures from Classical Laboratory Methods in General Chemistry." *Journal of Chemical Education* 13: 487–490; October, 1936.

Examples are given of experiments used at Hollins College which are designed to make students in the introductory course do some thinking for themselves. —V.H.N.

BAKER, C. P., AND WHITE, W. C. "Adapting the Project Method to Undergraduate Instruction in Chemical Engineering." *Journal of Chemical Education* 13: 484–486; October, 1936.

At Northeastern University in Boston students in chemical engineering take a course in plant design which offers an opportunity to obtain some very practical training by use of the project method. A group of students select a project which appears to be commercially practical and promising and plan the process, the plant for carrying it out, the cost of the entire project, and finally put their project into actual practice in the chemical engineering laboratory. —V.H.N.

OERLEIN, KARL F. "Mathematical Difficulty in College Physics." *The Mathematics Teacher* 30: 125–127; March, 1937.

It has been shown by a number of investigations that success or failure in college physics is determined to a large extent by the mathematical preparation of the students. The author, reporting certain findings from his doctoral dissertation at the University of Pennsylvania, presents evidence for the theses that physics teachers have gauged the mathematical needs in their courses and have kept within mathematical limits, that students are receiving credit for mathematics they have not mastered sufficiently for use in new situations, and that the mathematical situations in physics are sufficiently different that students fail to recognize

them without assistance. The crux of the situation, the author says, is that too much, rather than too little mathematics has been taught and that real mastery can be attained if fewer items carefully selected on the basis of use were taught in mathematics. —C.J.P.

## EDUCATION

Symposium. "Scope and Sequence as Applied to Curriculum Revision." *California Journal of Secondary Education* 11: 379; October, 1936.

This valuable contribution to one of the most significant problems in contemporary education includes the following discussions: "Scope and Sequence in the Curriculum," by Aubrey A. Douglass; "In the Area of Social Living," by Gertrude Miller Addison; "English and the New Educatio tion," by E. Louise Noyes; "The Dual Function of Music in Education," by Mary Elizabeth Ireland; "Art as Related to Scope and Sequence," by Margaret Erdt; "Foreign Languages as Guided by Principles of Scope and Sequence," by Isabella L. D. Grant; "Scope and Sequence in Relation to Science Education," by George Eby; "The New Mathematics," by Helen Geneva Lewis; "Factors Determining the Scope and Sequence of Major Learnings in Business Education," by Ira W. Kibby; "Homemaking Education in the Core Curriculum," by Maude I. Murchie; "Industrial Education in the Core Curriculum," by J. C. Beswick, and "Developing a 'Sequence' with Social Rootage," Paul L. Mackaye. —F.D.C.

Symposium. "Junior College Cultural and Vocational Completion Courses." *California Journal of Secondary Education* 11: 403–437; November, 1936.

This timely contribution to education in the important and rapidly developing junior college includes the following discussions: "The Place of Completion Courses in the Junior College," by Nicholas Ricciardi; "Completion Courses in the Junior College English Curriculum," by Alice Cecelia Cooper; "Science and Social Trends," by Frank B. Lindsay; "Social Studies and Completion Curricula," by Grace V. Bird; "Completion Courses and Personality Development," by Harry E. Tyler; "Music and Art as Junior College Completion Courses," by Edna Barr Love; "A Philosophy and a Program for Semi-Professional Training in the Junior College," by T. W. MacQuarrie, and "Vocational Completion Courses at Pasadena Junior College," by John W. Harbeson. —F.D.C.

JONES, LOUIS. "The Problem of Home Study." *California Journal of Secondary Education* 11: 448, 451; November, 1936.

This discussion includes discussions of parent opinion on home study, early articles on home study, surveys of home study which have appeared in the educational literature, the results of the Los Angeles survey of home study, legal restrictions, California laws on home study, suggested remedies, and conclusions. —F.D.C.

Anonymous. "A Million-pound Eye for Star Gazers." *Popular Mechanics* 68: 538–541, 133A–134A; October, 1937.

A good summary of progress and plans regarding the new 200-inch reflector being erected at Mount Palomar, California. Illustrations are excellent. Many interesting details of construction are given. —O. E. Underhill.

FREEMAN, FRANK N. "Heredity and Environment in the Light of the Study of Twins." *Scientific Monthly* 44: 13–19; January, 1937.

This is the résumé of a study involving 19 pairs of identical twins reared in different environments. Conclusions from the study: "It does not inform us whether heredity or environment is the most influential. It does indicate that the environment may affect all kinds of traits; intellectual, temperamental and social. It indicates that this influence is large enough to be of the greatest importance, and that human nature may be debased or improved to a degree which many have thought impossible. It probably indicates that we are far from having exhausted the possibilities of education and training for the enlargement of mental power and the improvement of behavior. It indicates large returns may be expected from a continued attempt to improve the methods of education." —C.M.P.

# New Publications

CHASE, CARL TRUEBLOOD. *Frontiers of Science.* New York: D. Van Nostrand Company, Inc., 1936. 352 p. $3.75.

*Frontiers of Science* was a selection of the Science Book Club for June, 1936. It need not be stated that this in itself is an excellent recommendation for the book. It is a survey of the achievements of the more recent scientific research. The book has a decidedly philosophical trend and tends to bring out the effect of the knowledge gained from research upon man and his place in the scheme of the universe. The material of the book, while confined to science, does not deal more with one branch of science than another. It tends as a whole to relate the material of each branch into an understanding whole. While the material with which the book deals is of a technical nature the author has carefully avoided bringing in those technicalities which would tend to confuse the reader rather than clarify his thinking. The material in the text is adequately and well illustrated by full-page cuts. This book may well be recommended for reading by the layman and the advanced scholar as the material is related in such a way that the perspective of the individual is broadened. The topics under discussion by the author are divided as follows: "Frontiers of Time and Space," "The Quest for the Ultimate," "The New Age of Chemistry," "The Frontiers of Health," and "The Secret of Life." The material is written in a pleasing manner and all points are adequately explained.

—F. L. Herman.

DOWNING, ELLIOT R., AND MCATEE, VEVA M. *A Learning Guide in Biology.* Chicago: Lyons and Carnahan, 1936. 314 p. $0.80.

This is a laboratory notebook in high-school biology for use by the student; the material is made up of problems with the attempt to develop skill in thinking. The units of work are based on biological principles that concern everyday life. The activities outlined are thought provocative. Drawings on many subjects are given. A list of visual aids, specifically lantern slides and films, is given with each unit. The book is bound in a paper cover, but each page can be torn out and reassembled in looseleaf notebook form. Page references to the different biology texts can be secured from the publishers.

—L.M.S.

BOYER, PHILIP A., CLARK, ARTHUR S., GORDON, HANS, C. AND SHILLING, JOHN. *A Learning Guide in General Science.* Chicago: Lyons and Carnahan, 1934-1935. 355 p. $1.28.

This manual presents problems with experiments to do in fourteen different phases of general science. First, the general presentation of the material, then a pretest, then the related problems with experiments offered for their solution, applications and questions for further study, with page references on the individual questions from a number of the leading textbooks of general science. Illustrated, worked out in great detail a wealth of valuable material is presented.

—L.M.S.

BOYER, PHILIP A. AND GORDON, HANS. *General Science Unit Tests, Arrangement B.* Chicago: Lyons and Carnahan, 1935.

A set of thirteen objective tests on the various phases of general science, approximately thirty-five to fifty items in each test.

—L.M.S.

BUSH, GEORGE L., PTACEK, THEODORE W. AND KOVATS, JOHN. *Senior Science, Socialized for the High School.* Cincinnati: American Book Co., 1937. 835 p. $2.20.

Another outcome of the comprehensive Cleveland Curriculum Study, this book is something really new at the senior high-school level. It presents "less formal science" to "the new fifty percent" of the high school students who will complete their formal education in a year or two. It does not compete, the authors insist, with any present course in physics or chemistry, offered for any of the present objectives of such courses in high school.

There are ten large units: Water; Fire; Fuels; Weather and Air; Foods and Medicine; Textiles; Building Materials; Home Equipment; Transportation; Safety—if you are curious as to their titles and order. Anyone can see that physics without the algebra, and chemistry without the formulas, may be offered liberally under these headings. The book will train no scientists, but it will arouse interest and curiosity. The treatment is broad rather than deep, but were there really thirty chemists ever developed in a class of thirty? The book is frankly non-vocational.

Those who object to this book and its treatment will include those who stand beside the deathbed of physics as a high-school subject and moan, "The Lord gave, and the Lord taketh away"; those who believe a smelly chemistry laboratory still saves souls; those who misunderstand the curriculum as meaning the Constitution, and protest any amendments. Those who favor the new-style course may be prophets or dupes a few years hence—for time will tell. Meanwhile, the course, and its comprehensive text, *Senior Science,* is worth an experiment in

any high school. A work-book has been prepared to accompany the text.

—H.A.W.

EDITORIAL STAFF OF POPULAR SCIENCE MONTHLY: *Wonders Through the Microscope.* New York: Grosset and Dunlop, 1934. 192 p. $1.00.

This is "a complete manual for amateurs," telling "how to use equipment, secure and preserve specimens, take photomicrographs" and so on.

It is illustrated with microscopic drawings. Popularly but carefully written, it will interest not only the adult amateur, but boys and girls in the upper grades and the high school. A copy should be in every school library for reference by both teachers and pupils. —L.M.S.

CARPENTER, FRANCES. *Our Little Friends of Norway.* New York: American Book Company, 1936. 213 p. $0.72.

This delightful book, one of a series of home-life readers for supplementary use in geography in the lower grades of the elementary school gives a sympathetic understanding of the people of Norway. It is written around the experiences of a boy and girl of the fiord region of western Norway and gives a vivid picture of the activities of the people of the region. The material is interestingly written and the book has real charm. The author has visited the region in preparation of the book. The book is attractively illustrated. —L.M.S.

FISHER, G. CLYDE. (Editor) *Nature's Secrets.* New York. The University Society. 940 p. $1.89.

This book is intended to serve as a guide in learning to know plants and animals and their habits. The book is divided into sections, each written by an expert in his particular field. The following sections are included: Knowing the birds; Mammals every one should know; Friends of the zoo; Things to know about reptiles; Amphibians; Insects; Spiders; Color as seen in the animal world; Bird houses and shelters; Knowing the flowers; and Trees every one should know. For each plant or animal discussed the following points are included: common and scientific name, general description, and interesting information about the form.

The book is well illustrated by seventy-four colored pictures, many photographs, and line drawings. Much of the print is small but since the book is intended for reference and not continuous reading this is not a disadvantage.

The book contains a wealth of accurate informational material appropriate for young people of junior and senior high school age as well as for adults who want to become better acquanted with living things. —F.G.B.

MOSELEY, EDWIN LINCOLN. *Trees, Stars, and Birds.* Yonkers, New York: World Book Company, 1935. 418 p. $1.60.

This is a revision of a book published in 1919. The new edition contains fourteen additional pages. New textual materials and pictures have been added bringing the content up to date. A few pictures have been eliminated while others have been exchanged for more appropriate ones.

As indicated by the title, the book is divided into three sections. The first section gives descriptions and interesting information about trees. Transplanting and care of trees is discussed in two chapters. Two other chapters consider the characteristics of common woods. A key for identifying hardwoods is included. Section two gives valuable information about the heavens with directions for using star maps. Section three gives descriptions of common bird families; outstanding markings of common birds; and the nesting and feeding habits of birds together with a discussion of their economic value.

The book is written in a clear attractive style. It is well illustrated by photographs, line drawings, charts, and fifty-eight colored plates of birds made from paintings by Louis A. Fuertes. It is stimulating and designed to encourage and guide young people in observing and enjoying the out-of-doors. It should find an important place in the library of every junior high school.

—F.G.B.

WEIDLEIN, EDWARD R. AND HAMOR, WILLIAM A. *Glances at Industrial Research.* New York: Reinhold Publishing Corporation. 1936. 221 p. $2.75.

This describes the Industrial Fellowship System as it operates in the Mellon Institute and gives examples of research promoted in this way. An industrial concern puts up the money and the institute assigns a qualified scientist to work on the problem for approximately a year. The donor has complete control as to results obtained, the results of the research not being released unless the donor desires it.

The history of the development of the store scales told in the chapter "Research Focuses on the Corner Grocer" is a fascinating one and gives real enlightenment into the way such a problem may lead into many and diverse fields of science. One might expect to find the Toledo Scale Company involved in research in synthetic resins in connection with scales but the way in which optical research by Bausch and Lomb, and research by The Aluminum Company of America enters into the picture may surprise you.

—O. E. Underhill

HUXLEY, JULIAN AND ANDRADE, E. N. daC. *More Simple Science.* New York: Harper and Brothers, 1936. 350 p. $2.50.

A fitting sequel to *Simple Science,* this supplementary book, in the same clear simplicity of manner, begins with the earth—its climates, continents, oceans, and soils—and goes on to discuss plants and animals which inhabit land and water, and tells how these things have come to be as

they are through the processes of heredity and adaptation. Finally, there is a brief summary of the history of scientific development.

It is one of the best pieces of popularization of science that has been done.

—O. E. Underhill

EICHLER, PHILIP. *A Philosophy of Science.* New York: G. P. Putnam's Sons, 1936. 109 p. $1.50.

To the reviewer this seems a confusing mass of verbalism, resulting from a hapless mixture of scientific and philosophic terminology. The result reads like so much metaphysics.

—O. E. Underhill

PETERSEN, CHARLES F. *Fundamentals of Electricity.* Milwaukee: Bruce Publishing Company, 1936. 112 p. $0.96.

This is a workbook designed for junior high school students. Forty-three lessons cover simple electrical circuits, bell wiring problems, telegraph set-ups, telephone circuits, etc. Five more elaborate demonstrations for teacher use are also described. Each lesson gives (a) purpose (b) references (c) procedure and materials (d) general information (e) questions (f) correlation. There are three tests included. The material is developed more or less from the trade-school or shop-job approach.

—O. E. Underhill

WHITE, C. LANGDON AND RENNER, GEORGE T. *Geography.* New York: D. Appleton-Century, 1936. 790 p. $4.00.

The sub-title calls this geography "an introduction to human ecology." The point-of-view is that the science of geography is concerned with a study of the relationships of man to his natural environment on the earth. The book is intended as a beginning college text in general human geography.

The organization treats of the climatic factors controlling human life; the biological factors of other animal life and of plant life; the effect of earth features; the effect of soils; mineral resources; water; space; and a summary section dealing with regional adjustment, ecological succession within a region, interregional relations, and geographical field study.

The content deals with material of greatest importance to all human beings at present. Much material that will illuminate many of the points now discussed under the heading of conservation can be found. The presentation will hold the interest of even the casual reader. It is an unusually well written college text. Illustrations are pertinent and striking.

This volume is recommended to the general reader, to the teacher of college geography looking for a new text, and to the high-school teacher of sciences, or of geography and history. It should be on the reference shelves of classes in general science and biology. —R.K.W.

MULLER, H. J. *Out of the Night.* New York: The Vanguard Press, 1935. 127 p. $1.50.

The sub-title on the cover of this small volume is, "A Biologist's View of the Future." This expresses the central theme of the work. The author is a professor of zoology in the University of Texas.

The book is in reality a collection of public lectures by the author in which he has attempted to predict what should happen as an outcome of man's increased biological knowledge. The lectures were given at different places over some period of time and finally collected and integrated to form the present book.

Chapters deal with the following topics: how has man been made; evolution a revolutionary doctrine; the next necessary step; we and the world in contest; the inner world; heredity and character; birth and rebirth.

The point of view is that of carrying biological control to its final conclusions in the control of human development. Many people, even many biologists, will not agree.

The book is recommended for rather mature students with enough previous training in biology to consider its proposals critically. Many of the suggestions deal with economic and social proposals which may not have basic grounding in social and economic thought other than in the author's opinion. —R.K.W.

BARROWS, HENRY R. *Elements of General Biology.* New York: Farrar and Rinehart, 1936. 435 p. $2.60.

The text presented here is a simplification and shortening of the author's earlier general biology. The present volume is intended for students who have had no previous training in biology. The shortened edition makes it possible to use the text for courses of one semester or one quarter in duration.

This book succeeds in keeping the point of view of a general biology without sacrificing the development of certain specific ideas pertaining to plants and animals separately.

The first chapter deals with the conditions necessary to life, and with the physics and chemistry of protoplasm, along with a treatment of the essentials of cell structure.

Following is presented the problem of classification of living organisms. One chapter deals with the general problem of classification. Following this is a treatment of plant classification. The succeeding chapter takes up the classification of animals. It is customary for many general biologies omit the classification and identification of living organisms. Professor Barrows retained this material and set it in place as functioning subject-matter.

The main body of the text deals with such topics as nutrition, responsiveness, endocrine correlation, cell division, reproduction, heredity, evolution, and the relationship of organisms to their environment.

This is a text that may well receive consideration by teachers of beginning biology in junior colleges. High school biology teachers will find it a useful reference. —R.K.W.

HOLMES, HARRY N. *General Chemistry.* New York: The Macmillan Company, 1936. 700 p. $3.50.

This is a third edition and further revision of a popular college chemistry text. The treatment follows in general that of the earlier editions. The pattern is that of the commonly accepted general chemistry course.

The introductory chapters deal with basic principles, combining proportions by weight, the atomic theory, and symbols, formulas, and equations. The following chapter begins the treatment of oxygen, and from this point the treatment is the customary one of the typical college course.

Toward the end of the book will be found a series of chapters dealing with such topics as hydrocarbons used as fuels, alcohols, fats and soaps, the carbohydrates, cellulose and rayon, food and nutrition, the special metals, alloys, electrochemistry, radiation chemistry, and colloid chemistry.

The book is up to date in its treatment of technical and industrial processes.

It is recommended for the consideration of college teachers of beginning chemistry. High school science teachers will find in it a valuable and useful reference. —R.K.W.

OLCOTT, FRANCES JENKINS. *Our Wonderful World.* Boston: Little, Brown and Company, 1935. 299 p. $2.50.

This book is a collection of one hundred thirty stories and articles that describe natural phenomena. The stories are told in a fascinating manner that stimulates the reader to want to experience for himself the wonders and beauty of the world. Forty of the stories are written by Miss Olcott. Among the other contributors are Commander Byrd and Amelia Earhart who tell some of their experiences above the clouds; Roy Waldo Miner who discusses corals; Albert Ramsey who interests the reader with his adventures in jewel hunting; Sir James Jeans and Sir Arthur Eddington who take the reader into the realm of the heavens; Roy Chapman Andrews with whom the reader goes to the Desert of Gobi and finds dinosaur eggs; William Beebe who gives interesting glimpses of the ocean floor; Enos Mills who tells about beavers at work; and John Muir who writes about the giant red-woods.

The book is illustrated by twenty-one excellent and appropriate photographs. It will be of interest to boys and girls of junior high school age and should find a place in school and home libraries. —F.G.B.

LANGFITT, R. EMERSON, CYR, FRANK W., AND NEWSOM, N. WILLIAM. *The Small High School at Work.* New York: American Book Company, 1936. 660 p. $2.75.

As the title indicates, this book is intended to give the reader information on how to make the small high school an efficient social institution. The content in every chapter centers around the problems of the high schools in the smaller areas of population which are so numerous in the United States and which are the typical secondary school institutions.

It includes 31 chapters in ten parts. The various sections discuss the setting of the small high school, relations to the community, guidance functions, curriculum considerations, extra-curricular activities, functions of the staff, organization and operation, financing, and means of assuring continuous progress in the light of recent trends in educational theory.

It is well organized, easy to read, and includes material which may be exceedingly useful to students in secondary classes in teacher-training schools, administrators, and teachers.

—A.W.H.

WALKER, HELEN M. AND DUROST, WALTER N. *Statistical Tables, Their Structure and Their Use.* New York: Bureau of Publications, Teachers College, Columbia University, 1936. 76 p. $1.60.

This is a timely book giving useful information on characteristics of good statistical tables. Part I discusses these characteristics in detail and includes ample illustrative material. Part II analyzes and criticizes sample tables constructively. Part III outlines the steps in making tables. The applications stress educational data.

The book is an excellent handbook for candidates for advanced degrees and those engaged in research work; or those who have need of constructing or interpreting tabular data.

—A.W.H.

STREBEL, RALPH F. *Nature of Supervision of Student Teaching in University Using Cooperating Public High Schools.* New York: Bureau of Publications, Teachers College, Columbia University, 1935. 155 p. $1.75.

This is a doctor's dissertation and includes discussions based on questionnaire data from forty-two universities having departments of education where practice teaching is done in cooperating public high schools. After postulating ten principles of student teaching, tabular material presents the professional status of the supervisory staff, supervisory activities during induction of the teacher into teaching, supervisory activities during responsible teaching, and a summary with recommendations and suggestions for additional studies. A bibliography is also given.

—A.W.H.

LINDER, ROSCOE GEORGE. *An Evaluation of the Courses in Education of a State Teachers College by Teachers in Service.* New York: Bureau of Publications, Teachers College, Columbia University, 1935. 156 p. $1.85.

In the investigation reported here the reactions to courses in education and related subjects were obtained from those who had taken these courses in one teacher training institution. The courses offered at Western Illinois State Teachers College in education, psychology, student teaching, supervision. sociology, and special methods were analyzed and a list of 328 different topics included in all these courses was obtained. This list was submitted to graduates of the college for the years 1926 to 1932 inclusive, junior and senior students of the school year 1932-33, and to the instructors of special methods courses. These persons were asked to check each topic with respect to occurrence in courses taken, applicability in work of teaching, value in development of professional background, value for leisure-time interests, repetition in different courses, and recommendation as to requiring or elimination from courses in the future. Fourteen hundred check-lists were sent out and slightly less than one-third usable returns were received. There is some indication that the sampling represented a selection from the upper part of the distribution of graduates approached, at least insofar as scholarship is concerned.

It is impossible to present an adequate review of the results here. It may be said, however, that the picture is not greatly different from that obtained by other investigators of the same problem. The degree of dissatisfaction with courses in the fields mentioned, and the amount of unnecessary and undesirable duplication between courses, are perhaps less striking as reported here than in some of the other studies. This may be due to closer attention to these matters at the institution represented in this study, to the fact that the better student tended to reply to the inquiry, or to a less critical attitude on the part of students in a teachers college to professional courses than is sometimes exhibited by university students. It also seems at times in reading the report that the author was unconsciously doing the best that could honestly be done to justify and support the existing program.

The study will take its place among its type as a painstaking attempt to find out what our students really think about courses in education. One may question the value of such opinion, especially when it depends upon checking 328 topics in each of six different categories, as in the case of this study, but the willingness to let students criticize the work displays a scientific attitude which specialists in other fields will do well to emulate. —V.H.N.

COX, PHILIP W. L. AND LANGFITT, R. EMERSON. *High School Administration and Supervision.* New York: American Book Company, 1934. 689 p. $3.00.

This long book is divided into ten parts and thirty-two chapters. The titles of the parts are as follows: "The Principal Orients Himself and His Job"; "The High School Principal as School Manager"; "The Principal Organizes His Teaching Staff"; "The Principal and Pupil Administration"; "Problems of Pupil Adjustments and Vocational Guidance"; "The Principal Promotes and Controls Student Activities"; "The Principal and Curriculum Adjustments"; "Supervision of Educative Processes"; "The Principal Expands His Job"; "L'Envoi (The Beginning Principal)." The parts include from one to as many as ten chapters, the longest section dealing with the principal as school manager. No important phase of high school administration is neglected.

The outstanding qualities of this book are first, its readability; second, its human and sympathetic point of view; and third, its progressive attitude. The book is actually interesting to read. Having served in administrative capacities in public schools, taught courses in high school administration, curriculum and supervision, and being familiar with most standard works in these fields, the reviewer frankly and gladly states that this book to him is most readable and refreshing. In its point of view it emphasizes the living, growing, experiencing side of secondary education. The book should be an inspiration and a live challenge to all administrators present or prospective, in secondary schools. Its discussions are full, clear, and practical; it tells what to do and when, and how, with the minimum of authoritarianism and a maximum of good humor and good sense. Finally, it is eminently progressive in its philosophy of secondary education. It sees the function of the secondary school in the light of the extra-curriculum rather than in the pale cold light of the academic curriculum. It speaks in terms of boys and girls rather than Latin and algebra.

On the negative side a few criticisms may be mentioned. First, it is doubtful whether any single volume of moderate size can hope to cover both high school administration and high school supervision. This one attempts it, and what is even more, attempts a rather full statement of what are generally called "principles of secondary education" besides. In a sense, therefore, the book attempts to be a three-in-one affair. The least adequately treated phase is supervision. What there is, is good, but it does not constitute a thorough treatment by any means. The book covers the other two phases well. A second criticism is that the two authors have not always completely reconciled divergences in points of view. That they should actually agree is beside the point, perhaps, but that the book should present a unified philosophy is highly desirable. Space forbids citing more than one instance of this. On page 350 it is stated that "Objective tests if correctly devised may measure information and skill outcomes of learning units. They cannot, however, measure attitudes, interests, or power to use the abilities measured." On page 547 it is clearly implied that generally accepted and reasonably adequate instruments have been developed for the measurement of attitudes, aptitudes, and character as well as the more definite

and tangible skills and factual learning. Finally, the authors criticize strongly such things as the marking system, credit for quality and the like, but they offer little in the way of specific and constructive suggestions for supplanting the system with a better one.

These criticisms are relatively minor ones with the possible exception of the first one mentioned. The book provides the basis for an excellent and thorough orientation course for prospective secondary school principals. —V.H.N.

Symposium. *Our Changing World.* New York: Thomas Nelson and Sons.

This series of books is edited by Dr. Rollo G. Reynolds, Principal of Horace Mann School, Teacher's College, Columbia University. It is an attempt to describe man's civilization and culture to boys and girls of later elementary school age. The books are written about subjects commonly included in school curricula. If children are studying transportation problems, interesting and accurate information about transportation is offered in the books, *Paddles to Propellers,* and *Ships Ahoy!* The series, when completed, will "present the stories of the past, particularly in relation to the present; and will picture the complex industrial civilization in which we now live."

The books are written in a challenging style and illustrated by block prints and line drawings. They should form a valuable part of every elementary school library.

A brief summary of some of the books of this series follows:

IRWIN, HELEN. *Paddles to Propellers.* 1934. 69 p. $0.50.
This is a story of transportation and travel in and about the Hudson River—first by canoes made by Indians, then sailing vessels followed by steamboats. The first locomotives are described as the forerunners of a great network of railroads reaching out in all directions. Transportation and travel have been extended to great ocean liners, freighters, tankers, private yachts, ferries, battleships, bridges, tunnels, and modern aircraft.

LIPMAN, MICHAEL. *How Men Kept Their Records.* 1934. 60 p. $0.50.
The development of printing as a means of keeping records from primitive to modern times is told delightfully in this story.

STOUT, VELMA. *Wires Round the World.* 1934. 52 p. $0.50.
This is a fascinating story of the development of telegraphy from the first telegraph used by Samuel Morse to the present day, when messages are sent by wire to all parts of the world.

HAYNES, MURIEL. *Our Electric World.* 1934. 67 p. $0.50.
The story of electricity used in a model city shows the dependence of man on this "slave" in home, hospital, industry, and in transportation and communication.

EDHOLM, LIZETTE. *Ships Ahoy!* 1934. 78 p. $0.50.
The story of sailing vessels is told by the captain of a skipper ship to Martin Drake, a young apprentice. Captain Everett's story is a result of practical experiences, extensive reading, and a lifelong interest in ships.

EVANS, WAINWRIGHT. *The Thunder Bird.* 1934. 70 p. $0.50.
This story tells how man learned to use and control fire. The author pictures the importance of fire in the development of modern civilization, and emphasizes the many dangers at present.

PHELAN, MARGARET S. G. *Candlelight Tales.* 1934. 68. p. $0.50.
These are true stories told by an elderly lady. In a fascinating yet simple manner, she tells of her life when candles were used for lighting, clothes were made of homespun cloth, soap was made at home, and straw ticks and featherbeds were used on beds. She describes in a charming way the work and play connected with storing the harvest for use during the winter.

—F.G.B.

BLOUGH, GLENN O., BRINK, IDA K., AND DOLMAN, HELEN: *Elementary Science for all Grades.* Dansville, N. Y.: F. A. Owen Publishing Company, 96 p. $0.50.

Excellent lesson material in science for all grades of the elementary school is found in this handbook. The material is extremely practical; it is rich in its suggestions for pupil activity of all kinds. At the same time the handbook covers a wide range of subject matter. It is written in an attempt to develop a scientific attitude in children; to arouse interest in their environment; to help in the acquisition of science information; and to provide science experiences which will develop children's powers of observation. Illustrations are provided and add to the usefulness of the book.

This handbook may also be obtained with a subscription (one year or more) to *The Instructor* at an additional price of only twenty-five cents. —L.M.S.

PRESTON, CARLETON E. *The High School Science Teacher and His Work.* New York: McGraw-Hill Book Company, 1936. 272 p. $2.00.

The book under review is the most recent work in this field. It consists of eighteen chapters of which about one-third deal with rather general problems such as teaching pupils how to study, and the remaining two-thirds deal with the objectives, subject-matter, and methods of science teaching. Each chapter is followed by exercises for report and discussion, and by a short list of selected references. There is a preface, a foreword to the student, and an index. In his preface the author states that he has attempted to write as "a practitioner, not as a theorist." In keeping with this purpose, one finds little reference to research studies except citations as already noted. In fact, the body of reading material is almost never punctuated by documentation. There are less than a half dozen footnotes in the whole book. This makes for uninterrupted reading but introduces the danger of appearing to be dogmatic. However, one does not receive this impression in reading the book. The author presents his ideas simply and clearly and with modesty.

The book should prove popular and useful as a text for undergraduates. It is short and easy to read. It includes more material of a general nature than might be considered necessary, especially if students in a special methods course for prospective science teachers have already

had a general course in methods of teaching in secondary schools. Most of the students in a course where this book might be used as a text will probably have had such a general methods course.

It is the reviewer's opinion that the whole treatment could have been strengthened by occasional reference to source material, especially reports of important research studies. The author is skillful in avoiding pedantry and dogmatism but occasional support of his views by well-chosen reference to research findings would have added strength. Most of what he writes is either good common sense or well-substantiated by research.

As an introduction for the young and totally inexperienced prospective teacher of science this book will prove practical and helpful. The author stays for the most part on tried and proven ground. The point of view throughout is genuinely progressive and forward looking. Occasionally he makes a slip when he discusses matters not strictly in the field of teaching science as in his definition of reliability of a test as given on p. 228 and again on p. 229. According to this definition validity and reliability are actually synonymous which is certainly not the case.

The publishers are to be commended for a fine piece of work. The volume is excellent in printing and format. —V.H.N.

CROXTON, W. G. *Science and the Elementary School.* New York: McGraw-Hill Book Company, 1937. 454 p. $3.00.

Elementary science teachers and others who are interested in furthering, directly or indirectly, the elementary science movement will welcome this book most heartily. The book is intended for the use of elementary science teachers who are either actively engaged in teaching, or are teachers in training. Satisfactory elementary science readers have appeared in sufficient numbers in recent years to at least partially meet the needs and demands for supplementary reading materials for pupils. Not so with suggestive material for the use of teachers. There has been a real dearth of this type of material. *Science in the Elementary School* will go a long way toward filling this gap.

Part I provides a comprehensive theoretical basis for the teaching of science at the elementary school level. The author's stated philosophy and underlying assumptions seem to be in accord with the best and most progressive thought in elementary science. Part I discusses (1) Education as development through interaction, (2) The place of science in the elementary school, (3) Aims in science teaching, (4) The importance of method, (5) Science in our changing elementary curriculum, (6) Appraising the results of our methods, (7) Preparing to teach elementary science, and (8) Research contributions and needed studies in the field of elementary science education.

Part II, comprising the major part of the book, gives suggestions for an activity program. It is intended to serve as source material. Activities are listed according to seasons, and are developed under the headings: (1) Aims; (2) Suggestions; (3) Contributing learnings, and (4) References.

Professor Croxton is a well-known teacher of elementary science in the State Teachers College at St. Cloud, Minnesota. The suggested activities are based on both his own and others' classroom experiences. Altogether the book meets an urgent need in a most satisfactory way. Students in the reviewer's class have been delighted with the style, diction, and practical usefulness of the book. —C.M.P.

FLETCHER, GUSTAV L., MOSBACHER, IRVING, AND LEHMAN, SIDNEY. *Unified Physics.* New York: McGraw-Hill Book Company, 1936. 662 p. $1.80.

This book is an attempt to overcome many of the defects found in many high-school physics texts. The book is very well illustrated with carefully selected cuts, diagrams, and pictures. At the end of each chapter is a test using the completion type of question to serve as a summary of the chapter. These questions tend to emphasize principles as against a large accumulation of facts. Many problems of varying degrees of difficulty are also included at the end of the chapters. These are about all the text contains to make it different from other high-school physics texts. —F.L.Herman

CHAPMAN, WENDELL, AND CHAPMAN, LUCIE. *Wilderness Wanderers.* New York: Charles Scribner's Sons, 1937. 318 p. $3.75.

Here is a book of unusual charm and instructiveness. Its authors quietly rebelled against office and apartment life. Their original purpose was to "take to the woods" when a promising business career had built competence adequate to make living in the mountains economically possible. But like many others, their developing fortune was given a knock-out blow by the depression. Instead of delaying mountain life, this hastened it, for the authors decided to take what funds they salvaged and live in the mountains anyway, and at once. Off to the highest ranges they went, living in tents and rude shacks, and making friends with all sorts of wild creatures. Altitudes, snows and winds, which drove practically all other humans and most other animals down for shelter, proved to be real opportunities for Mr. and Mrs. Chapman. The genuine hardships of living and travelling at the higher levels in severest weather are simply described, but with unction, and not the slightest complaint.

They write much about the ways of beaver, about which so much had already been written that one wonders what could be new. But what they say is new because of the intimate and really personal acquaintance that was developed.

Then, the close-up study of bighorn sheep adds to what was previously known of that rare animal. Perhaps, they argue, these sheep are not more rare than decades ago, but keep away from people more successfully than almost any other animals of the highest Rocky Mountains. The bighorn rams form separate groups and live more or less peacably together until the approach of the late autumn breeding season. Meantime, the adult females, the lambs, and yearlings live in groups usually at high altitudes but not so high as those in which the old bucks live. In these female family groups one old ewe dominates a whole group. She and any contender fight viciously for leadership. The primitive technique of these fights consists in having the contenders rush together from a distance of thirty or forty feet, striking their heads squarely with all the momentum they can acquire. Often horns are broken and sometimes heads are broken open, and some sheep are killed. But when a winning leader is thus selected, the further dictatorship is absolute. The selection is not by popular vote but by severe and prolonged demonstration of superior strength. The bighorn rams come down from the higher levels and fight it out when the breeding season approaches. Their fights are more ferocious and disastrous than those of the females. The leader is sure to be a strong, agile, courageous and enduring individual, else he could not defeat and drive away the ambitious contenders. Even his nearest foes, who entice away a few of the ewes, are sure to be good individuals, else they would be kept away by the younger and weaker rams. Nature's severe methods for insuring a strong paternal inheritance surely provides something for a wobbling human race to think about.

Also, there come in for enticing discussion the elk, buffalo, bears and mountain goats, the rarest and strangest of all, which were studied in the highest Canadian Rockies.

In originality, friendliness to wild nature, closeness of observed details, and pleasing style this book is highly commendable.

—Otis W. Caldwell

LOEWY, RAYMOND. *Locomotive.* New York: The Studio Publications, Inc. (London), 1937. $2.50.

This is a volume consisting of 125 photographs with annotations. The first twelve are of the early locomotive inventions, some of which were never carried to actual construction, but these early stages in transportation "on rails" are most interesting. Then follow various leading types of locomotives shown entire, and a few details for special purposes. Streamlining effects are especially displayed. The author expresses his notions about present-day streamlines as follows: "It will be very interesting if not amusing, twenty years from now, to look again at streamlining's early efforts in the railroad field."

This whole pictorial presentation in excellent photographs will prove valuable for historic comparisons of the developments in an important aspect of applied science. —Otis W. Caldwell

VERRILL, A. HYATT. *Strange Insects and Their Stories.* Boston: L. C. Page and Company, 1937. 201 p. $2.50.

Insects are thought to be among the oldest animals which have inhabited the earth, following the Protozoa. They are also among the most recent, if considered from the point of view of their readjustment to modern conditions and the constant reports of new species. Indeed, it is guessed by entomologists that not half the existing species are yet officially listed and adequately described, and there are over 300,000 species already described. One prominent entomologist says that insects are increasing in numbers and range of their food habits to such an extent that it is an open question whether men or insects will dominate the earth. Those facts, and others, indicate the importance of such popular accounts as those which compose this book.

This is not a textbook on entomology, but readable accounts of striking, usually unobserved insect structures and habits. In the main, the forms discussed are not treated according to their structural relationships, but according to their habits. This feature is shown by such chapters as the following. "Insect Gems" includes the Brazilian beetle, the dogbane beetle, the Caribs, and ground beetles, all beetles to be sure, but selected because of their striking colors. There is no attempt to present beetles as a group. The small wasp which pollinates figs has one whole chapter which is presented because of its economic relationships. "Some Giants of the Insect World" tells the story about the largest known insects, this section including fossil as well as living forms. Insects which hide through mimicry make up a chapter. Another deals with insects which are luminous. Ants are treated under the caption "Some Incredible Ants," and strange spiders, scorpions and ticks compose a chapter called "Insects That Are Not Insects."

The book is quite suitable for use as a reader in upper elementary school and junior high school. —Otis W. Caldwell

GREGORY, WILLIAM K., AND RAVEN, HENRY C. *In Quest of Gorillas.* New Bedford, Conn.: The Darwin Press, 1937. 241 p. $3.50.

It is possible that some conservationists may take exception to the main ideas expressed in this volume. Gorillas live in their native jungles of Africa. They are fearful of humans whom they resemble in certain most striking ways. They move about usually in small groups. They devour huge quantities of succulent vegetation, often the bananas or other plants grown by native farmers. They make a new home each night, making individual beds of brush and leaves. Each group has a strong leader who has won and holds his leadership by strength and cunning not too unlike the qualities through which human leadership sometimes expresses

itself. In bodily structure, far more than in habits, these animals appear to be close to men in the order of ascending complexity. Why should men invade the gorillas, home, kill specimens, and bring them back to our laboratories and museums? Should not the Belgian and French governments, which control most of the gorilla country, forbid all interference with the normal life of the gorillas? These are not new questions, but those who read this volume will thereafter know much more about the facts out of which to construct their own answers. This reviewer does not undertake to formulate the answers, except to say that science is justified in this method of gaining material for highly important additions to knowledge.

The men who composed the American Museum party in 1929 were granted permission to take two gorillas if they could. They wanted one large male of the Belgian country's gorilla, and one from the French chimpanzee country. The story of the arduous trips into the jungles, almost all unsuccessful, is a fascinating one, full of information about the natives, the country, and the habits of the objects of the search. Finally, a large gorilla was killed in the deep jungle. Then came the heroic task of getting the specimen back to camp where every part of its body was preserved for shipment and subsequent laboratory study. This was repeated with a later and a less satisfactory specimen. Also, there was secured the live baby specimen, since known as "Meshie," who lived in Dr. Raven's family until it became wise to place her in a zoological garden.

Dr. Gregory, gifted literateur who has written most of the account, is a scientific naturalist. All sorts of sciences find their way into his pages. While abundant and excellent photographs by Dr. McGregor and others are used, Dr. Gregory's sketches are no less instructive and entertaining to the reader. Although the main purpose of the trip was to secure specimens for scientific study of gorillas, the authors were always alert to all sorts of manifestations in the range of zoology, geology and landscape. They present a measure of information about plant life, though in most instances the perplexing vegetational cover was more of an object for attack by the machéte than by the botanical investigator. Much interesting data is presented regarding the life and doings of the humans who live in the regions visited. The book gives one a trip to Africa. —Otis W. Caldwell

PEARSON, T. GILBERT. *Adventures in Bird Protection.* New York: D. Appleton-Century Company, 459 p. $3.50.

Born in Tuscola, Illinois, early boyhood amongst his family's Quaker associates in Eastern Indiana, moved again as a boy in 1882 to the village of Archer, Florida, thence to North Carolina to school and college, then hurrying from one state to another, even to several foreign lands, throughout the decades of mature life,—such have been the seemingly hectic shifts of the author of this autobiography. But they were not "hectic shifts." For as a small boy birds were the lodestone which held attention and gave major purpose to a remarkably busy, ingenious and useful career. The whole story makes up the epic of America's progress in learning the place of birds in our social, agricultural and aesthetic life.

During Pearson's boyhood birds were things to shoot at, and most of them to be eaten or used in millinery decorations. Birds on women's hats are absurd now, but once quite the thing. Even the mocking birds were shot and eaten by some of young Pearson's acquaintances, but an early experience shows how an unfounded superstition may do some good. The colored cotton picker, Aunt Celie, told the boy, "Honey, when you gets big enough to tote a gun don't never kill nary a mockin' bird. Every one of them little fowls takes kyer of some good man or woman what's daid, and when you hear one asingin' at night, you knows that some good soul done come back and is walkin' about. A spirit kaint never leave its grave lessen its mockin' bird hollers for it to come out." But egg collecting was regarded as all right, and in a few years he had collected, labeled and arranged the eggs of all the birds whose nests could be found by long and often dangerous journeys. Exchanges enlarged the collection. Sales made possible the meagre funds with which the North Carolina schooling started, and work in small natural history museums not only provided means for going on with college work, but was the occasion for appointments to teach college faculties.

Then began the well-known campaign against destruction of birds. Legislation, law enforcement, cooperation with other naturalists, organizations of Audubon societies, raising funds for legal campaigns, and hundreds of other activities were cared for with unusual energy, and singleness of purpose. The book is filled with detailed accounts of an almost unbelievable number of enterprises all focused upon protection of bird life. The names of cooperators and the things done by all make the book an epic record of bird protection in America, and to a considerable extent in the whole world. So packed with information in story form is the whole book that no review can do much more than to say that the full story is here for all who are interested. This book will be recognized for many a day as a graphic and fascinating account of a highly important part of American natural history. —O.W.Caldwell

W.P.A. Federal Writers' Project in the City of New York. *Who's Who in the Zoo; Natural History of Mammals.* New York: Halcyon House, 1937. 211 p. $1.69.

This book consists chiefly of very excellent photographs of mammals found in the animal houses in New York City parks and gardens.

The photographs are the work of excellent camera men, mainly those attached to the zoological or park staffs, and most of them are from negatives belonging to the New York Zoological Society.

The text descriptions are meagre, many pages being partly blank, though no end of interesting data might have been culled from the same sources from which the writers evidently secured the data they have presented. No claim is made that new or original observations are reported. The assemblage of excellent photographs makes a good book, but the text is interesting chiefly in showing how the study has been used in the adult education of the W.P.A. workers who did the writing.

—O.W.Caldwell

LEE, RICHARD E. *The Backgrounds and Foundations of Modern Science.* Baltimore: Willaims and Wilkins Company, 1935. 536 p. $4.00.

This is a revision of a work first published in 1932. It is designed as a college freshman orientation course through the integration of the natural sciences. It emphasizes the techniques and philosophy of the scientific approach toward the organization of knowledge rather than the content of the sciences. Part 1, "An Introduction" of problems of life with the techniques of science may play, and indeed must play, if progress in their solution is to be made. Part 2, of four chapters, discusses the origin of the scientific and philosophic techniques, defines them, and states their relationships. Part 3, in eight chapters, discusses the development of modern scientific techniques. The chapters deal with the universe and man's attempt to formulate descriptions of its nature, the problem of life, the psychological aspects of man's attempt to know nature, the evolution as a unifying technique, applying it to cosmic and inorganic as well as geological and biological systems. Part 4 (seven chapters) gives the historical backgrounds of the development of these techniques. The fifth and last section "A Special Study of Various Aspects of the 'Primary Stuff' of the Universe" presents an articulation of the techniques of the 19th and 20th centuries. These chapters are very short, from one page to three or four. However, each of these chapters has a page or so of exercises, many of which involve laboratory experimentation. Several blank pages follow each exercise page for the student to use in noting his answers to the exercise questions.

—O.E.Underhill

DARROW, KARL K. *The Renaissance of Physics.* New York: The Macmillan Company, 1936. 306 p. $3.00.

Dr. Darrow discloses in this book that rare ability to discuss technical scientific matter in non-technical language, making the subject both interesting and easily understood by one scantily trained in science. He gives the historical development which has led to our present-day conception of matter and the composition of the atom. He gives as the latest theories of the oneness of light, electricity and matter. The chapters are entitled: "Physics and the Physicist"; "Intimations of Electricity"; "Release of Electrons from Matter"; "Through Measuring to Knowing"; "Magnets and Moving Charges"; "The Atom Visible"; "Light in the Semblance of Waves"; "Mystery of Waves and Corpuscles"; "Structure of the Atom"; "Technique of Transmutation"; "Victory over the Elements"; "Unity of Nature."

—W.G.W.

WRIGHT, FORREST B. *Electricity in the Home and on the Farm.* New York: John Wiley and Sons, Inc., 1935. 320 p. $2.50.

This book is primarily of the vocational type. It would be an admirable text when used in connection with courses in the Industrial Arts as well as in short agricultural courses. The material is organized on the basis of "jobs." Each job is set up as a unit with suitable drawings or other illustrations to clarify the material and the principles involved. All of the material is definitely authoritative yet is made simple enough so it can be readily understood. Questions on each "job" are found at the conclusion of the job to serve as reviews. Much valuable general information is contained in the book which might serve as a reference text in courses in physics. This text is definitely on the high-school level. If one accepts the philosophy of education that students of the high-school level should be trained for living, then this is a very good text for such training.

—F.L.Herman

TAYLOR, F. SHERWOOD. *The World of Science.* New York: Reynal and Hitchcock, 1937. 1064 p. $3.75.

This is a comprehensive treatment of the whole field of natural science written for the person who wishes to know the answers to the many questions which are continually arising in his mind in this age of scientific applications. It is written by an Englishman from the viewpoint of the scientist who surveys the entire field in a rather systematic manner.

The six parts are arranged to explain the states of matter, power, waves, chemistry, the earth and heavens, and life, respectively. Each part is subdivided into from five to eleven chapters. The first three parts survey the field of elementary physics; the fifth, elementary astronomy; and the sixth, elementary biology. Part IV includes eleven chapters surveying elementary chemistry. The last chapter in the book, "Looking Ahead," outlines some of the possibilities in future scientific discovery.

The book is attractively assembled and illustrated with 677 halftone and line illustrations.

—A.W.H.

DENT, JOHN YERBURY. *The Human Machine.* New York, Alfred A. Knopf, 1937. 294 p. $2.50.

This book is written by an English physician and is an attempt to explain the problem of man as a machine from an objective viewpoint in so far as man is able to judge himself impersonally. It includes 13 chapters, followed by an additional chapter classified as an appendix. The treatment is extremely original. The writer has attempted to free himself from all preconceptions which have been advanced heretofore as unproved theories of the behavior of the individual.

Dr. Dent attempts to trace man from the primordial, inorganic elements, suggesting the protoplasm and the living cell as the beginning of life both plant and animal. He suggests all growth as an evolution in response to environmental forces and conceives society, a collection of individuals, as a larger unit to be explained similarly from the same premises.

Two interesting chapters deal with "Hypnosis" and the "Subjective and Objective Viewpoint." The appendix chapter is a general criticism of psychoanalysis as it is practiced at present. Dr. Dent indicates that it uses man's reactions to the superstitions of religion as a new type of exploitation of the credulous.

The book will be found very interesting to the man with a scientific bent who enjoys attempts to explain present life and existence from the beginning to the end mechanically and objectively. Naturally such an explanation imposes a great burden upon the human mind but it provides an intriguing and stimulating adventure. —A.W.H.

PITT, FRANCES (editor). *Nature in the Wild.* New York: Charles Scribners' Sons, 1936. 95 p. $2.00.

This is a collection of over 100 excellent photographs of nearly every type of mammal and bird, selected from the International Exhibition of Nature Photography at the British Museum of Natural History. The photographs are indexed both by subject and contributor. These are some of the finest animal photographs the reviewer has seen. Many of them are unique shots such as those of the lyre-bird erecting its tail, the egret, a bull sea elephant, and wild animals of India and Africa. Yet perhaps these are of no more interest than the photographs of our common birds and mammals because of the unusual character of the pose and arrangement: the erect fin of a dolphin throwing up a thin film, its dark shadow reflected in the water; a flash-light shot of a deer leaping from a pond, catching the drops of spray and the splash of its hind legs; a gannet, wings forward and coasting to a three-point landing, or a swan just "taking off." Any lover of good photography or anyone who enjoys detailed observation of animal life will return to these photographs again and again. —O.E.Underhill

MILLIKAN, ROBERT ANDREWS, ROLLER, DUANE, AND WATSON, ERNEST CHARLES. *Mechanics, Molecular Physics, Heat, and Sound.* Boston: Ginn and Company, 1937. 498 p. $4.00.

This new text in the field of physics appears to be a distinct addition to the literature of this field. As is stated in the preface, the text is a revision of the earlier text entitled *Mechanics, Molecular Physics and Heat.* The material of the present text has been improved over that contained in the previous work. The material seems to be to develop the general principles involved. For this reason the book is very readable. A great deal of historical material has been introduced at appropriate places throughout the text. The sources of the materials contained in the text are given at the bottom of the page. At the end of each chapter a "Question Summary" and "Problems" with answers are given. The material of the book is well illustrated. The illustrations are simple and clear. Throughout the book an effort is made to advance the student in the mathematics needed. Each of the important formulae is developed adequately and the mathematical steps necessary in arriving at a final equation are clearly shown. This reviewer has found the material easy to read. There are wide applications included which materially add to the interest. The students should find it easy reading.

The book is a decided attempt to produce a text which will serve a dual purpose. It is intended as a basic background for the serious student in Physics or the Sciences and allied fields as well as for the "non-science major." The material is so designed that it may be used with or without the mathematical treatments. For the science student an understanding of the calculus will be found to be advantageous. On the whole, this text should find a definite place in teaching of Physics to college men and women. —F.L.Herman

THOMSON, SIR J. J. *Recollections and Reflections.* New York: The Macmillan Company, 1937. 451 p. $4.00.

This book, written by one of the world's foremost scientists, is an amusing, interesting, and true to life record of the events in the life of this famous man. As one reads the book he cannot help but be struck by the humanness of the events in the school and teaching life of Sir J. J. Thomson. One may rest assured that the events in his life are accurately recorded. In addition to the many interesting happenings in his outside-of-school activities, he set forth the basic principles, fundamental reasoning, and the experimental work of many of his researches. His colleagues in his work and on the faculties are discussed with an utter frankness so that one receives the impression of having seen these men through the eyes of the author. Probably the book may be best described by saying, "To read it is to realize the full and interesting life of a man and a scientist." This book should be interesting reading to the lay public as well as to the scientist and of people from the high-school age upward. —F.L.Herman

BRISCOE, HERMAN T., HUNT, HERSCHEL, AND WHITACRE, FRANCIS M. *A Laboratory Manual of General Chemistry.* Boston: Houghton Mifflin Company, 1936. 155 p. $1.75.

This manual embodies a unique and ingenious construction; by means of a double set of spiral bindings the manual is separated into two parts, which, by means of a double fold may be folded into the size and space of an ordinary 8×11 notebook. One part contains the directions for each experiment. The other contains correspondingly arranged report sheets for the student to fill out. When the manual is opened flat, both sheets for a given experiment are visible to the student. They are perforated so they may be torn out and passed in to the instructor. The manual is planned for a full-year college freshman course of four laboratory hours per week. The experiments follow the traditional organization with somewhat greater emphasis on the quantitative aspects than is sometimes found.

—O.E.Underhill

MOSELEY, SYDNEY A., AND MCKAY, HERBERT. *Television.* New York: Oxford University Press, 1936. 144 p. $2.00.

The subject of television is one of popular interest. There is a good deal concerning this subject that is highly technical and involved. In *Television* these theories and principles have been placed upon a more popular basis. Each step in television up to the present is explained, and yet the principles have been kept intact. While the authors are English, they have included many of the developments in television which have originated in the United States as well as in other parts of the world. For a simple comprehensive treatise of television to date, this book exceeds others of this type. The volume must not be considered as a technical treatise on the subject of television but is in the popular vein and can be read and understood by the untrained lay reader. —F.L.Herman

GLASSTONE, SAMUEL. *Recent Advances in General Chemistry.* Philadelphia: P. Blakiston's Son and Co., 1936. 430 p.

This book is an attempt to relate the modern atomic principles to the processes of chemical reactions and behavior. The attempt has been remarkably well done, and many hitherto little understood chemical phenomena begin to take on meaning and reality when treated by this author's clear and careful presentation. The processes of thought carried out by the author are logical and clear. While there are points about which there may be some doubt, in the main his explanations are the logical outgrowth of modern atomic theory. The author uses basically sound references. These greatly enhance the value of the book. This reviewer feels that a book of this sort has a logical place in basic chemistry courses as well as a supplementary text in physical chemistry or the broad review courses sometimes given at the completion of college chemistry courses.

—F.L.Herman

HARLOW, ALVIN F. *Old Wires and New Waves.* New York: D. Appleton-Century Co., 1936. 525 p. $5.00.

This is an excellent and delightful story of communication. Teachers of science in the junior high school and grades who wish to approach a unit on communication from the social science point of view will welcome the detail with which early communication systems, such as the Greek torches and the semaphore, are given. Liberal quotation from original sources and contemporary writings dealing with the telegraph, telephone and the more modern means of communication adds greatly to the interest of the book. Thirteen chapters are devoted to the telegraph. One welcomes those chapters which show the relation of this development to the building of the American "empire," the railroad, and discuss the economic and social implications as well as the scientific principles. The detail which is given with regard to the points out of which litigation over patents arose will offer opportunity for high-school physics students to see if they can apply what they have learned about electricity. The details of the controversy as to how much of the credit for inventing the telegraph should go to Morse or Henry is both interesting and enlightening. Five chapters are devoted to the telephone and four to the development of the radio. The reviewer is inclined to agree with the author, who, in his preface, calls attention to the disproportion in space given to the telegraph as compared with more recent invention, and then asks, "May it not be suggested that the birth and infancy of ideas are intrinsically more noteworthy, more important, than their middle age?" He considers that changes in the more modern forms of communication are constantly described in newspaper and magazine, that they are changing so rapidly and their retails so complex, that it is better in a book of this sort not to chronicle all the minor details of recent communication development. An excellent bibliography of primary and secondary sources is given. —O.E.Underhill

LEMON, HARVEY BRACE. *Cosmic Rays Thus Far.* New York: W. W. Norton and Company, Inc., 1936. 128 p. $2.00.

This book is an up-to-date resume of the history, study, and the development of knowledge of cosmic rays. It is written in the popular trend and has the same style as that used in the more elementary texts in the physical sciences published by the University of Chicago Press. Even though the book is of a popular nature, the facts and theories are authoritative. These facts and theories are so stated that the ordinary untrained individual can read and understand them with ease. There is a foreword written by

Arthur Holley Compton which in itself lends authority to the book. On the last two pages of the book the names and nationalities of all the individuals mentioned in the body of the text is given. The book will be found to be interesting to all classes of people from the senior high school upward. The book is illustrated by many drawings of the usual type found in the University of Chicago's elementary texts with but two important photographic reproductions. —F.L.Herman

STEMEN, THOMAS R., AND MYERS, W. STANLEY. *Oklahoma Flora.* Oklahoma City, Okla: Harlow Publishing Corporation, 1937. $6.00.

Excellent as the "floras" and "manuals" covering some regions of North America and Europe are, their very scholarly treatment puts them definitely beyond the use of many who are anxious to know the plants that form such an integral part of our lives. It requires technical training, a high I.Q., and a stout heart to attempt identification where only such tomes are available.

This makes a volume like *Oklahoma Flora,* which covers a less extensive area, all the more valuable. Within its 706 pages are included descriptions of 640 genera and 1626 species. These are arranged according to families and are appropriately keyed. The family, genus, and species accounts are clear, relatively brief, and terse. Such valuable additional data as type of habitat and distribution, comparative abundance, and time of flowering are also given. The 494 clear illustrations will be of assistance and of solace to those less expert in handling keys. Grasses, sedges, and rushes are not included in this book.

Toward the end of the volume there are six appendices dealing with the significant topics of wild flowers meriting protection, hay-fever plants of Oklahoma, plants poisonous to eat and to touch, drug-producing plants included in the flora, aquatics useful in natural history, and edible plants of Oklahoma. Those with a unique epicurean bent may try the suggested menu for a "native dinner."

The authors have produced a volume that will be exceedingly helpful to those in Oklahoma who wish to learn the plants of their region. The book is not unduly simple, but neither is the flora. —Edwin B. Matzke

The Carnegie Foundation for the Advancement of Teaching. *Thirty-first Annual Report.* New York: 522 Fifth Avenue, 1936. 193 p.

The report is published in four parts discussing, respectively, the work of the year, educational enquiry, administration of the trust, and necrology notes.

In "Youth and Educational Abstractions," Dr. Jessup, the President of the Foundation, shows that "the school remains the one youth movement upon which there has been widespread and general agreement, with which we have had three centuries of experience on all levels from infancy to manhood."

In "Tested Achievement of Prospective Teachers in Pennsylvania," William S. Learned cites alarming data which indicate the need for much improvement in recruitment and selection of teachers for our schools. "A candidate must know the specific thing he is to teach, but his eventual worth as a teacher is contained in the perspective of the thing he teaches against the thing he is in his complete intellectual and emotional character," he says, and adds, "Our present system of pigeonholing a small, traditional group of ideas in the mouth of a specialist, then requiring a student to accept and respect those bounds and put together an education out of technical bits contributed by uneducated people, has never worked except in the minds of school and college registrars.—Thoroughly educated teachers who know more than their texts and who are free and ready to help a pupil wherever and whenever his problems become acute—there is no other formula."

Alfred Z. Reed discusses the "Contribution of the Medieval University to American Higher Education," emphasizing four basic ideas. "One is that there are fields of knowledge within which systematic teaching may profitably be given to adults. Another is that some, at least, of the organizations which provide this teaching should be largely independent of either ecclesiastical or secular control. A third inheritance is a belief in the value of knowledge for its own sake, for as many as can secure it. A fourth is our entire apparatus of academic degrees."

Other sections include reports of grants for educational research, provisions recently made for autonomy of the Teachers Insurance and Annuity Association, notes on the Carnegie Centenary, and financial reports.

One who examines the report cannot fail to be impressed by the great work which this organization is doing in the field of American education. —A.W.H.

KANDEL, I. L. *Examinations and Their Substitutes in the United States.* New York: The Carnegie Foundation for the Advancement of Teaching, 522 Fifth Avenue, 1936. 183 p.

The book includes four chapters: "The Problem of Examinations and Its Social Setting"; "The Traditional Examination"; "The Scientific Attack on Examinations"; and "Education, Examinations, and the Individual"; an appendix discussing the International Examinations Inquiry; and a preface by Dr. Walter A. Jessup, President of the Foundation.

Much of Chapter I is taken up with a comparison of secondary education in Europe and the United States to show traditional differences emphasized by our democratic mode of life, but to indicate tendencies toward a fundamental integration of ideas. "On both sides the fundamental issue is slowly ceasing to be one of selection and is becoming one of distribution, or

the discovery of the right education for the right pupil under the right teacher."

A brief history of examinations in Chapter II introduces the reader to studies disclosing unreliability and invalidity of current systems of examining and grading which eventually led to experimentation with new type tests and the cumulative record system for individuals based on test records supplemented by many other valuable data. Experimentation with new type tests and statewide examination practices are discussed and the Cooperative Test Service explained. Considerable attention is given to the Pensylvania study to show the need for cumulative records and educational guidance in the schools. Samples of cumulative records are given and ten criteria for cumulative records developed.

In discussing the function and underlying importance of examination studies, the following statement is summarizing: "The task . . . is to read and interpret the results of examinations in such a way as to discover what is best for the individual's education and through the individual for the society in which he lives. The validity of an education will accordingly have to be defined in terms of the needs both of the individual and of society." —A.W.H.

MENDENHALL, JAMES E. (editor). *Building America.* Published by the Society for Curriculum Study through the Columbia University Press, 1936. $2.50.

Teachers familiar with the Building America materials which have been issued in pamphlet form will welcome this first bound volume. This material is published with the assistance of the Lincoln School of Teachers College, Columbia University and the United States Works Progress Administration. The "illustrated studies of modern problems" in this volume cover housing, food, men and machines, transportation, health, communication, power, recreation, and a final unit entitled "youth faces the world." The executive committee and the editorial board of the Society is composed of the leading educators of the country. Science teachers who are becoming aware of their responsibilities in directing the attention of their pupils to the social significance of scientific thought, will do well to follow the Building America publications. They will find there ample suggestion of opportunity for integrating their work with that of the social science field. Mathematics teachers will be interested in the techniques of using graphs, which are illustrated. —O.E.Underhill

HULL, Ross A. (Editor). *The Radio Amateur's Handbook.* West Hartford, Conn.: The American Radio Relay League, Inc., 1936. 536 p. $1.00.

The new edition of this popular handbook of radio has been greatly enlarged, extended and much new material has been added. The general arrangement of the contents has been kept essentially the same. As a reference and guide in radio for the amateur this handbook has no equal. Everything which is necessary for the prospective amateur has been included as well as hints and suggestions for the present operator. As a text it may be used in elementary courses in radio and even for the advanced student there is a wealth of very practical and useful material. Included in the text of the handbook are circuits and the explanations of the essential electrical principles so necessary for a complete understanding of modern radio communication. Since the main purpose of the handbook is for the use and instruction of the amateur operator it necessarily deals with codes, transmitters, operating techniques, and receivers and transmitters in the assigned amateur bands. The handbook does not deal extensively with the modern commercial type of receiver but the basic principles are of course included in the amateur band as well as in the standard broadcast band. The latter part of the handbook is devoted to radio law and the methods of handling messages. This section has been brought up to date and is thoroughly reliable. —F.L.H.

DUBOIS, GERTRUDE AND FRANCES. *Peter and Penny Plant a Garden.* New York: Frederick A. Stokes Company, 1936. 207 p. $1.25.

Dedicated to "Our Gardening Fathers," this practical garden book for young children tells in story form how a small brother and sister made their first garden while they attended school and did the other things which young children do. The book begins in September with the planning of the garden and follows the children through the twelve months of the year.

At the end of each section is a summary of the activities of the children and statements of what the children learned are given at the end of the first month. Black and white drawings and flower decorations add to the attractiveness of the publication. The entire book is in conversational form. —C.J.P.

GRUENBERG, BENJAMIN. *Science and the Public Mind.* New York: McGraw-Hill Book Company, 1935. 196 p. $2.00.

In the Foreword to this book, John C. Merriam states that this study on the place of science in relation to adult education makes clear the importance of science to the public and presents an extremely interesting and valuable picture of the types of activities in existence, or which may be created.

The author, in his preface, justifies inflicting another book upon the public on the bases that the schools cannot longer keep up with the civilization it is designed to preserve, that the school, as conventionally conceived and conducted, is unable to keep up with science, that the adult population must draw increasingly from science the guidance essential for the perpetuation of democratic ideals and conditions, and that adult education is seriously lacking in the field of science.

The study was undertaken at the invitation of the American Association for Adult Education and the report represents the interaction of many minds upon the various aspects of the relationships of science and adult education. General conditions, trends and needs are summarized and interpreted. In Part I is discussed, under seven chapter headings, "The Place of Science in Modern Life." Part II considers "Means and Methods of Bringing Science to the Public." "The Educational Situation," as it relates to science in adult education, provides the title for Part III.

Especially suggestive are the sixteen theses concerning science in individual and cultural interests contained in chapters 2 and 3 of Part I. We quote two of these as examples: "1. Usable knowledge affecting health, comfort, practical management of personal and vocational affairs are of direct help to everybody" and "11. An appreciation of the achievements of science among the forces that have molded our daily life and our present-day economic, social, and political relationships would make for more reliance upon expertness in dealing with public questions, and less upon traditional authority or power." Each of the theses is interpreted briefly and some are documented.

The author's discussion of the failure of science to reach the public will be of great interest to all science teachers and leaders who attempt to promote science in adult education. Among the reasons given for this failure are: (a) indifference of educators, (b) lack of teachers who will give of their time, (c) low esteem of popularization of science by educators and scientists, (d) the suspicions of the public regarding science and its effects upon life, (e) indifference of scientists to understand public wants, and (f) the irresponsibility of science to social, economic and political conditions and problems.

—C.J.P.

ARNOLD, HERBERT J. *The Selection, Organization, and Evaluation of Localities Available for Unspecialized Field Work in Earth Science in the New York City Region.* New York: Bureau of Publications, Teachers College, Columbia University, 1936. 229 p. $1.75.

Based upon the assumption that one of the important reasons for teaching science to laymen is to give them an understanding of the principles and generalizations of science which ramify widely into human experience, the investigator proceeds (a) to select certain generalizations from the field of geology as meriting a place in the science curriculum, (b) to develop a technique for the selection of localities and materials suitable for illustration of these generalizations, and (c) to discover what materials and localities are available within a reasonable distance of New York City for the illustration of these generalizations.

It is stated by the author that the first of the three purposes may be considered the least important of the three. With this statement one might take issue in view of the basic assumption on which the dissertation rests. Certainly, in a field as broad as geology is, it is essential that great importance be attached to the selection of the generalizations "which ramify widely into human experience." However, the investigator does make a careful analysis and determination of the generalizations of earth science, applying the techniques of Craig, Billig, Pruitt, and Billings, with certain modifications. Books, written by authorities in the field of geology, or related fields, as non-technical reading for the layman and recent geological literature dealing with the New York City area were analyzed. Specific criteria were applied to the selection of the sources.

The outline of generalizations, presented on pages 36 to 46, is a most valuable contribution. The fact that each of these generalizations had a frequency in the sources of three, or higher, does not furnish a necessarily valid basis for believing that it is of significance in the everyday life of the layman. There is danger in an outline of this kind that teachers will revert to the teaching of subject matter as an end though this is not a responsibility of the author.

In the selection of the localities suitable for geologic field work and in the illustrations, descriptions and interpretations of the localities and phenomena observable in the New York City area, the author has done a superb job and has made an outstanding contribution to professionalized subject matter in science. He has set a technique and a pattern of thought which teachers, even those not so well trained in the field of geology as he is, may follow with pleasure and profit in their own regions. The kind of field work here described may become a real part of science teaching, as it should become, if teachers will read and gain teaching technique and inspiration from the author's contribution.

—C.J.P.

WEBB, HANOR A. *The High-School Science Library for 1936–1937.* Nashville, Tenn.: the author, George Peabody College for Teachers, 1937. 15 p. $0.15.

This thirteenth annual list of reference and textbooks maintains the high standard which the author has set in earlier lists and which, we trust, all science teachers have examined with profit.

Opportunism, the author says, characterizes this new list. He adds, "more books on photography than usual . . . syphilis is discussed in several volumes without shame . . . there is a distinct slump in aviation references."

The usual mechanical arrangement is employed, the books being coded into groups costing ten, twenty-five, fifty, one hundred, two hundred, and over two hundred dollars. The popularity and value of these lists by Webb should make it unnecessary to recommend the new list to every science teacher and every librarian.

—C.J.P.